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MEMOIRS OF THE GEOLOGICAL SURVEY

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SPECIAL REPORTS ON THE MINERAL RESOURCES OF GREAT BRITAIN.

N.B.

NGI. STORAGE

VOL. XXI.—LEAD, SILVER-LEAD AND ZINC ORES OF CORNWALL, DEVON AND SOMERSET.

MENDIP
N.B. P60 – 66 !

BY

HENRY DEWEY.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.

GEOLOGICAL SURVEY OFFICE WHITEHALL

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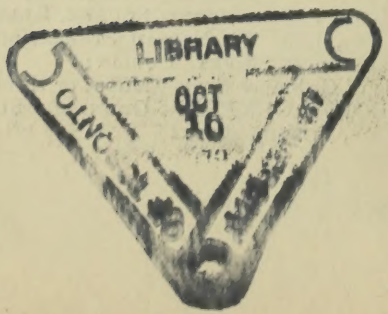
PREFACE BY THE DIRECTOR.

In this memoir Mr. Dewey has brought together the principal facts regarding mining for the associated ores of lead, zinc and silver in the south-west of England. The early history of the industry is obscure and belongs to a distant period, but for several centuries the metals of this group have been produced in considerable amounts from a large number of mines widely scattered through Cornwall, Devon, and Somerset. As a whole the output has declined of recent years and has at times come almost to a stand-still; as compared with mining for tin and copper the mines of this group are of secondary importance in the district, but they have always been a great training ground for miners and mining engineers and a repository of mineral specimens many of which now enrich the collections of our museums. All available sources of information have been searched for particulars of the older and abandoned mines, and by personal visits the mines still working have been examined and the plans and records consulted. As far as possible the lodes of this series have been inserted on the 6-in. geological maps of the Geological Survey which may be consulted at the Museum in Jermyn Street, London, S.W.1.

We wish to express our indebtedness for information with regard to the mines of West and Central Cornwall to Messrs. Scott, Marshall, Paull, Taylor and Faull, and for those of North Cornwall to Messrs. Fitzmaurice, Oliver and Swete. Mr. J. G. Hamling of Barnstaple kindly placed at our disposal many records of mines in North Devon and our thanks are due to him and to Prof. S. H. Reynolds for particulars of mining in the Mendips.

JOHN S. FLETT,
Director.

Geological Survey Office,
28, Jermyn Street,
London, S.W.1.
12*th March*, 1921.



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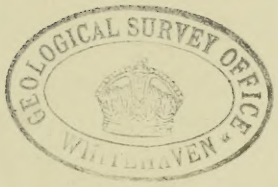

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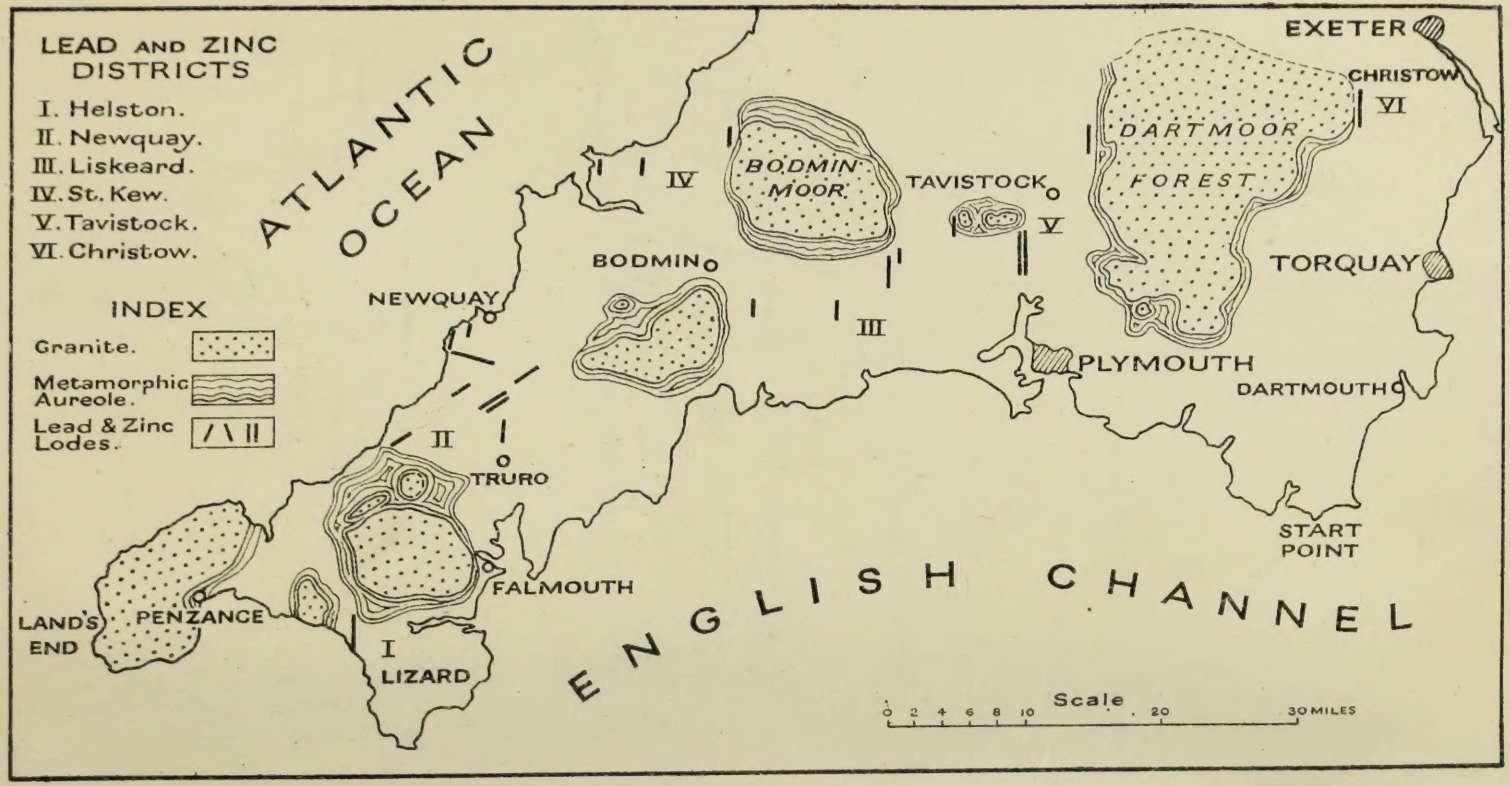
PLATE. I.
[Frontispiece]



Map of the Lead-mining districts of Cornwall and South-Devon.

LEAD, SILVER-LEAD AND ZINC ORES OF CORNWALL, DEVON AND SOMERSET.

CHAPTER I.

INTRODUCTION.

Distribution.—The principal districts in Cornwall and Devon where lead-ores have been worked are indicated by thick black strokes on the accompanying map (Plate I). The most productive were those situated between Truro and Newquay, near Liskeard, and between Plymouth and Tavistock. The less important mines are those near Helston; some others in the neighbourhood of St. Kew, Padstow, and Camelford in North Cornwall; and the group in the Christow Valley, on the east of Dartmoor.

Lead-ores.—On the map it will be seen that each granite-mass is surrounded by a belt of highly metamorphosed rocks, and that the lead lodes never occur in the granite and seldom in these belts. The country rock is either a sediment or, more rarely, lava or ash, and never an igneous rock of intrusive origin. There is a significant association of lead-ore with argillaceous sediments, which is apparently general in Cornwall and Devon; and lodes which course through interfolded beds of slaty and sandy killas are rich in the former and barren in the latter. This phenomenon is well illustrated by sections (Plates III and IV) where the stoped ground is entirely in shaly killas. The Beer Alston lodes were rich in lead-ore while in slate, but became barren near the granite.

Most of the lodes course from north to south; a few, and those rich ones, course nearly north-east, and one or two in other directions.

On being mined the lead-ore in the lodes was found to deteriorate in depth and finally to die out. In some lodes it was gradually replaced by ores of copper. At the points of intersection of east and west by north and south lodes there was not a notable amount of admixture of ores, but normally a local enrichment of the lead-ore, while the ores of copper became argentiferous.

Mr. J. H. Collins[1] estimated the total quantity of silver contained in the copper-ores sold between 1501 and 1900 at $28\frac{3}{4}$ million ozs. and that the proportion of silver was $2\frac{1}{2}$ ozs. to the ton of copper-ore. The lead-ore of Cornwall and Devon

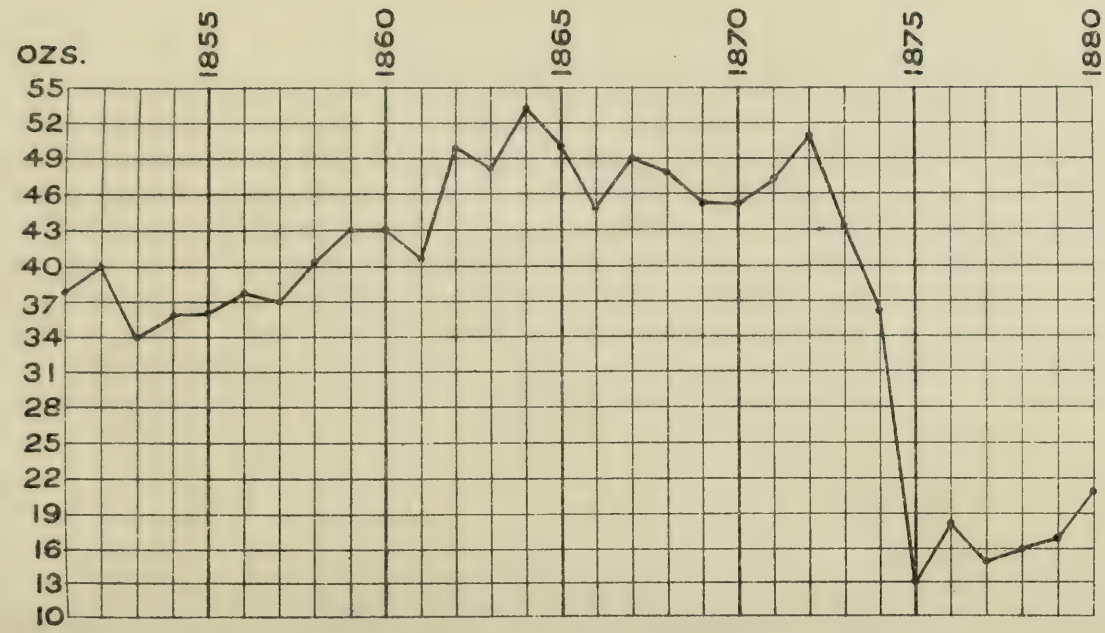
[1] "The Precious Metals in the West of England," *Journ. Roy. Inst. Cornwall*, Vol. XVI, Part 1, 1904, pp. 103–119.

is notably rich in silver, averaging about 40 ozs. to the ton. The relation of the zinc-ores to those of copper is close, blende being a common constituent of many of the east and west lodes, even of some in the granite.

The principal ores of lead and zinc are galena and blende. Calamine is rare in Cornwall and Devon, and cerussite has been found only in the gossans, or in the lodes just below them. Many lodes had good gossans which contained minerals derived from sulphides and arsenides by the action of surface waters, as well as others formed from emanations given off from the deep-seated magmas. The principal gangue mineral is quartz, which assumes a variety of forms; but the minerals composing the gangue were not the same in each district. At the Chiverton Mines (District II) quartz was the principal mineral, no fluorspar or barytes having been observed. The lodes at the Herodsfoot Mines (District III) contained some rare and beautiful minerals including rich bunches of tetrahedrite, but fluorspar was rare. In the neighbouring mines, Trelawny, Mary Ann, Wrey and Ludcott, the lodes were characterised by an abundance of fluorspar, barytes, and chalcedonic quartz. At Wheal Mary Ann barytes was abundant down to the 40-fthm. level, but below that level was represented by pseudomorphs. Other phenomena at these mines were the large vugs often lined with galena and pyrites, and the abundance of carbonate and phosphate of lead in the higher levels. One lode contained numerous large and perfect crystals of barytes and fluorspar; and at Wheal Ludcott there were rich silver-ores. Some beautiful gossan minerals were found in the lead lodes of North Cornwall (District IV). At Pentire Glaze Mine, cerussite was common, while in some neighbouring mines the galena was rich in silver and was associated with pyromorphite and ores of antimony. At the Old Treburgett Mine there were some shoots of silver-ore containing antimony, mixed with galena poor in silver. Fluorspar was common in the lodes at the Beer Alston Mines (District V), but rare in the mines of the Christow Valley (District VI); barytes, however, is abundant at the latter locality and is still worked in one mine.

The depth to which the ores of lead have been worked does not greatly vary and averages 140 fthms. It is apparently not affected by the proximity of the granite masses. Near the Godolphin granite the Penrose Mines are less than 100 fthms. deep. The mines between Truro and Newquay lie about midway between the granite masses of Carn Menelez and St. Stephen's, but do not attain a greater depth than 140 fthms. At Wheal Mary Ann, four miles from the Bodmin Moor granite mass, lead-ore was worked to a depth of a little over 300 fthms. This is the maximum depth for the West of England. North-east of the same granite the greatest depth is 110 fthms. At Holmbush near Kit Hill and at Beer Alston, the lodes were worked

PLATE. II.



Graph shewing ounces of Silver per ton of Lead from Cornish Mines

respectively down to 170 fthms. and 150 fthms., and at Wheal Betsy to 140 fthms. At the Christow Mines the greatest depth was 145 fthms., while at Combe Martin, in North Devon, it was 120 fthms. With the exception of the lode at Wheal Mary Ann lead-ore appears to approach exhaustion between 140 and 200 fthms. below the surface.

Silver-ores.—Although there are no silver-mines in Cornwall and Devon, ores of silver and native silver have been found in many of the lead and copper mines. The principal ores are argentite, pyrargyrite or ruby silver, and cerargyrite or horn silver. The first discovery was made about 1788 at Wheal Mexico, Perranzabuloe, in a north and south lode or cross-course. The chief producers were Wheal Darlington, Dolcoath, Wheal Ludcott, Wheal Duchy, Wheal Newton and Herland. Silver-ores have been found from the surface down to 120 fthms., mainly at about 20 fthms. and usually in cross-courses. They seldom form long or deep shoots and tend to be replaced downwards by galena. The richest parts of the lodes were at their points of intersection with copper lodes and it frequently happened that there were rich shoots near slides or flucans.

The amount of silver in galena is variable and the association between the two appears to be mechanical. Where rich silver-ore was met with in a lode bearing galena, the galena was always poor in silver. Variation with depth does not appear to be constant, for in some lodes the galena near the surface was richer in silver than that deeper down, while in others the reverse obtained. At the Beer Alston Mines galena from the upper parts contained 145 ozs. of silver per ton, and that from the lower only 35 to 40 ozs., whereas at the mines near Liskeard the lead-ore was richer in silver in the deep levels.[1]

The ores richest is silver were found in the Chiverton Mines, where there were from 40 to 50 ozs. of silver to the ton of lead; and in the Herodsfoot-Ludcott groups where the silver varied from 40 to 55 ozs. The ores poorest in silver occurred in the East Wheal Rose and the Cargoll Mines where silver varied from 9 to 20 ozs. and at Wheal Golden where it was only 14 ozs. per ton of lead. In North Cornwall the lead-ore contained 45 ozs. of silver per ton and a similar amount was found in the lead-ore of East Cornwall and the adjacent parts of Devon. The lead-ore from the Christow valley mines contained 18 to 25 ozs. of silver. The average for Cornwall between 1851 and 1882 was 42 ozs. per ton. Plate II shows the yearly average from 1850 to 1880. The sudden fall between 1872 and 1875 is due to the closing of many mines where the most highly argentiferous galena had been raised.

---

[1] Henwood, W. J., *Trans. Roy. Geol. Soc., Cornwall*, Vol. VIII, 1871, pp. 110–121.

Zinc-ores.—These have not been worked to any great extent in Cornwall and Devon. The ore occurs most commonly as sulphide, and is known as blende or Black Jack. It is frequently associated with ores of copper, but rarely with those of tin. Most of the output of zinc-ore from Cornwall came from mines in the parishes of Perranzabuloe and Newlyn East and mainly from the Duchy Peru Mine. Some blende was raised recently at New Wheal Leisure near Perranporth, and a lode was being prospected in 1919 at Wheal Sally near St. Agnes. All these mines are in District II, the area of rich lead-ores. Small quantities of zinc-ore are raised occasionally at the tin mines near Redruth, and there is a good lode at Tresavean.

Output and Yield.—The recorded output from Cornwall and Devon does not represent the whole of the ores mined as the earlier statistics are incomplete, but as it stands it shows an aggregate of 311,049 tons of lead-ore.[1] The figures for lead smelted and of silver obtained from the lead are also incomplete. The total amount of silver is 7,062,750 ozs. Mr. J. H. Collins estimated the quantity of ore mined and metal obtained from it for the period 1845 to 1886. The figures are approximately 350,000 tons of lead-ore containing 280,000 tons of lead and 7½ million ozs. of silver. "But the mining of silver-lead ores had been going on for 600 years previously, and perhaps longer, some of the mines having been rather extensively wrought, and very rich in silver . . . the output of the six centuries was at least as great as for the period 1845–86, and this would bring up the total lead to 560,000 tons and the contained silver to 15 million ozs." He then estimates the amount of vein-stuff removed to win the ore, and concludes that "it would appear that 586,667 cubic fathoms of ground have yielded 560,000 tons of dressed lead-ore, or say, 5 per cent. of the total weight of ore-ground excavated."[2]

In North Devon lead-ore has been worked near Barnstaple in a series of short north and south lodes in the Middle Devonian (Ilfracombe) Beds. These beds are either slightly calcareous slates, or limestones. At Combe Martin several strong lodes have been mined for several centuries in rocks of the same age. The lead was argentiferous. Lead-ore was worked at the Upcott Mine, North Molton, in an east and west copper lode which contained about 1 per cent. of lead and some silver.

The Mendip Mineries.—The lead-ore consists principally of galena or lead sulphide and the zinc-ore of calamine or zinc carbonate. The greater part of the galena has occurred in the Carboniferous Limestone, where some zinc blende is associated

[1] Collins, J. H., *Trans. Roy. Geol. Soc., Cornwall*, Vol. XII, 1905, p. 715.

[2] *Trans. Roy. Geol. Soc., Cornwall*, Vol. XII, 1903, pp. 715–717.

with it. Calamine is rare in the Carboniferous Limestone, but occurs normally as a cement in the Dolomitic Conglomerate which lies irregularly on the upturned and partly denuded edges of the earlier formations. It also forms small veins and stringers. Galena has been found in this conglomerate in angular pieces and also lining internal cavities of shells and plants. The normal associates of galena in the lodes and other ore-bodies in the Carboniferous Limestone are calcite, barytes and quartz, but there is no record of fluorspar. The slags left by Roman and other early miners were rich in lead and have been treated at several periods for the recovery of the metal,[1] but scarcity of water and coal tend to make such enterprises unremunerative. Lead-ore has also been found in deposits in-filling deep cavities and containing Mesozoic fossils, especially Liassic forms.[2]

Some consider these in-filling materials to have gained access to the fissures in the Glacial period, and account for the presence of the metalliferous ores by the waste of lode material. The fissure-material contained at times as much as 7 per cent. of galena.

History.—The earliest period of lead-mining in the West of England is unknown, but it is probable that lead-ore was mined on the Mendip Hills in pre-Roman times. That it was worked extensively by the Romans is proved by coins and pigs of lead, bearing inscriptions of several emperors from Claudius to Antoninus Pius,[3] which have been found among the heaps of slag and tailings. The earliest written documents referring to the mines of Devon bear the date 1293,[4] when the mines of Beer Alston and Combe Martin were producing ores of both silver and lead. These mines were worked intermittently up to the 19th century. Of the Cornish lead mines, those first worked appear to be Wheal Pool, Wheal Penrose, and Wheal Rose near Helston. Carne[5] states that in 1818 these mines had been in work for more than 250 years; and Stephens[6] that Wheal Rose was worked during the Roman occupation. Pryce[7] in 1778 stated that Wheal Golden was formerly wrought under the sea. Most of the large lead-mines were started in the middle of the 19th century and closed down between 1880 and 1890. Of the mines still active the principal are Old Treburgett near Camelford; Wheal Sally, near St. Agnes; and some small mines in North Cornwall. Dumps are being treated at West Chiverton.

---

[1] Hunt, R., "British Mining," 1884, p. 36.

[2] Moore, C., "On Abnormal Conditions of Secondary Deposits." *Quart. Journ. Geol. Soc.*, Vol. XXIII, 1867, pp. 449–568.

[3] Hunt, R., "British Mining," 1884, pp. 34, 35.

[4] Lysons, "Magna Britannia," Devon, p. cclxxxv, quoted by De la Beche, "Report on the Geology of Cornwall, Devon and West Somerset," 1839, p. 611.

[5] *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 119, 120.

[6] *39th Ann. Rept. Roy. Corn. Poly. Soc.*, 1871, p. 77.

[7] "Mineralogia Cornubiensis," 1778, p. 21.

Output of the Cornish Lead Mines.[1]

Year.	Lead-ore.		Lead.		Silver.
	Tons	Cwts.	Tons	Cwts.	Ounces.
1845	10,110	0	6,063	0	—
1846	8,228	0	4,933	0	—
1847	11,574	0	7,304	0	—
1848	10,223	0	6,614	0	—
1849	10,494	0	6,614	0	—
1850	10,325	16	6,773	0	—
1851	9,515	4	6,709	3	255,640
1852	8,998	14	6,220	6	250,008
1853	6,680	3	4,690	5	165,670
1854	7,460	1	5,005	10	179,675
1855	8,962	19	5,882	8	211,348
1856	9,973	13	6,597	4	248,436
1857	9,559	16	6,036	7	224,277
1858	9,710	0	5,436	15	223,189
1859	7,842	15	4,985	12	215,964
1860	6,401	3	4,242	15	180,757
1861	6,690	14	4,228	20	173,344
1862	6,030	5	4,119	0	205,662
1863	6,259	14	4,270	15	206,313
1864	5,301	17	3,538	12	192,232
1865	6,546	11	4,296	8	214,659
1866	6,736	10	4,350	11	195,218
1867	8,644	19	6,480	11	314,326
1868	8,415	16	6,310	9	303,033
1869	9,023	3	6,775	0	305,714
1870	8,481	5	6,360	0	292,045
1871	7,565	14	5,672	18	267,234
1872	5,463	10	4,098	15	207,710
1873	3,909	10	2,923	0	129,509
1874	3,119	14	2,337	3	85,304
1875	2,566	10	1,932	2	25,681
1876	2,727	0	2,070	0	37,650
1877	2,166	13	1,673	17	23,035
1878	1,394	14	1,022	2	16,456
1879	725	5	544	18	9,435
1880	753	18	570	5	11,750
1881	764	17	408	8	14,396
1882	624	1	454	1	11,460

Output of Lead- and Zinc-ores from Cornwall, and the amount of Lead and Silver in the Ores of Lead, from 1883 *to* 1913.[2]

Year.	Lead-ore.	Amount of Lead in the Ore.	Amount of Silver in the Lead.	Zinc-ore.	Zinc obtained by Smelting.
	Tons.	Tons.	Ozs.	Tons.	Tons.
1883	830	588	9,445	2,807	626
1884	529	352	5,000	1,290	352
1885	241	160	2,500	1,031	281

[1] Hunt, R., "British Mining," 1884, p. 898.
[2] From the "Home Office Statistics."

Year.	Lead-ore.	Amount of Lead in the Ore.	Amount of Silver in the Lead.	Zinc-ore.	Zinc obtained by Smelting
	Tons.	Tons.	Ozs.	Tons.	Tons.
1886	227	168	2,200	749	263
1887	Nil	—	—	649	228
1888	Nil	—	—	134	64
1889	Nil	—	—	129	60
1890	Nil	—	—	—	—
1891	Nil	—	—	—	—
1892	15	11	—	12	6
1893	Nil	—	—	21	10
1894	Nil	—	—	57	—
1895	Nil	—	—	—	—
1896	7	—	—	55	7
1897	Nil	—	—	57	—
1898	Nil	—	—	—	—
1899	Nil	—	—	42	—
1900	Nil	—	—	20	—
1901	Nil	—	—	237	—
1902	Nil	—	—	—	—
1903	9	—	—	10	—
1904	Nil	—	—	—	—
1905	248	—	—	4	—
1906	200	—	—	38	—
1907	190	—	—	450	—
1908	87	—	—	50	—
1909	Nil	—	—	824	—
1910	—	—	—	—	—
1911	—	—	—	300	—
1912	—	—	—	—	—
1913	—	—	—	—	—

Output of Lead-ore, Lead, Silver, and Zinc-ore from the Mines of Cornwall, grouped according to the Parishes in which they occur. The Lead-ore raised since 1845; *the Silver since* 1852 *and the Zinc since* 1853.[1]

Parish.	Lead-ore.	Lead.	Silver.	Zinc-ore.	Remarks.
	Tons.	Tons.	Ozs.	Tons.	
Bodmin - -	10	7	80		
Callington -	6,640	4,230	10,200	25	Silver obtained from lead, but the amount is understated. Copper also yielded some silver.
Calstock -	215	140	1,810	10	270 tons of silver-ore. Before 1833 over £10,000 of silver-ore sold.
Camborne -	110	75	—	645	340 tons of silver-ore.
Camelford -	180	108	—	—	
Cardinham -	20	15	—	—	
Crowan - -	10	7	15	3	
Cubert - -	1,150	720	6,550	—	

[1] From "Summary of Progress of the Geological Survey of Great Britain for 1906" (*Mem. Geol. Surv.*), Appendix I, pp. 135–139. For the output of lead-ore, lead and silver from the parishes of Devon *see* MacAlister, D. A., *ibid.*, 1920, Appendix V, 1921, pp. 96–102.

Parish.	Lead-ore.	Lead.	Silver.	Zinc-ore.	Remarks.
	Tons.	Tons.	Ozs.	Tons.	
Egloshayle	55	33	—	—	
Falmouth	900	180	3,580	—	
Gwennap	25	18	—	—	4 tons silver-ore.
Gwinear	some	some	—	400	2,610 ozs. of silver from silver-ore, and also £9,000 of silver.
Gwithian	75	55	—	25	
Illogan	800	535	13,900	270	
Kea	3,870	2,750	58,150	2,000	
Kenwyn	2,150	1,170	74,200	1,390	
Lanivet	—	—	—	156	
Lanreath	19,530	14,270	617,270	—	
Lelant	—	—	—	10	
Linkinhorne	90	65	290	105	
Liskeard	some	some	—	—	
Marazion	some	some	—	10	14 tons of silver-ore, yielding 3,440 ozs. of silver.
Menheniot	53,690	44,210	2,010,000	—	
Newlyn (East)	5,720	41,705	412,825	4,070	
Padstow	75	56	270	—	
Perranuthnoe	some	some	21,000	—	
Perranzabuloe	55,620	40,020	1,321,000	58,760	185 tons of argentiferous copper, 7 tons rich silver-lead-ore.
Phillack	410	305	5,000	110	
Redruth	—	—	—	25	
St. Agnes	115	80	30	290	
St. Austell	325	200	950	980	
St. Blazey	some	—	—	980	
St. Cleer	—	—	—	240	
St. Enoder	15	10	3,000	—	
St. Erth	—	—	—	1,400	
St. Hilary	65	40	—	—	
St. Ive	10,850	7,410	298,250	—	12 tons silver-ore, 156 tons rich silver lead.
St. Ives	—	—	—	300	
St. Just	5	4	—	—	
St. Kew	30	21	—	—	
St. Mewan	20	12	50	—	
St. Minver	990	658	19,070	—	
St. Neot	140	95	1,010	—	
St. Stephen in Brannel	480	314	2,970	—	
St. Teath	2,180	1,640	9,530	45	
St. Winnow	4	3	40	215	Some silver-ore also.
Sithney	120	12	—	4	
South Hill	280	150	9,170	—	8 tons silver-ore.
Stoke Climsland	2,000	1,310	21,150	1,125	53 tons copper and silver precipitate.
Tywardreath	—	—	—	50	
Warleggon	20	12	140	—	

In drawing up the accounts of the mines, published information has been used freely. The mines received special attention during the 6-in. survey of Cornwall and Devon by H.M. Geological Survey. All available plans and sections were examined, and the information respecting the position of lodes and cross-courses, and, wherever possible, their underlie, was transferred to the 6-inch geological maps. There was therefore already much information available on these maps and in the accompanying explanatory memoirs. The excellent descriptions of the mines by W. J. Henwood, H. C. Salmon, Webb and Geach, and, more recently, J. H. Collins, were in all cases made use of. The plans of abandoned mines deposited at the Home Office have been re-examined; their registered numbers are given for each mine in the following abbreviated form: H.O. Plan No. and Date. We are much indebted to the mine managers for information regarding recent work and assistance while visiting the mines. The memoirs referred to above are shown in the following list. Reference is made to them in abbreviated form under the description of the mines.

Memoirs of the Geological Survey describing districts where lead- and zinc-ores occur :—

"The Geology of the Land's End District," Sheets 351 and 358, by C. Reid, J. S. Flett and others. 1907.

"The Geology of Falmouth, Truro, Camborne and Redruth," Sheet 352, by J. B. Hill and D. A. MacAlister. 1906.

"The Geology of the Lizard and Meneage," Sheet 359, by J. S. Flett and J. B. Hill. 1912.

"The Geology of the Country near Newquay," Sheet 346, by C. Reid and J. B. Scrivenor. 1906.

"The Geology of the Country around Plymouth and Liskeard," Sheet 348, by W. A. E. Ussher. 1907.

"The Geology of the Country around Padstow and Camelford," Sheet 336, by C. Reid, G. Barrow, and Henry Dewey. 1910.

"The Geology of the Country around Tavistock and Launceston," Sheet 337, by C. Reid and others. 1911.

"The Geology of the Country around Newton Abbot," Sheet 339, by W. A. E. Ussher and others. 1913.

CHAPTER II.

WEST, CENTRAL, AND NORTH CORNWALL.

I.—The Helston District.

This district embraces the old mines of Wheal Penrose, Wheal Rose, and Wheal Pool, and sundry smaller mines about which but little is known. There have been several occurrences of rich silver-ore in this and the neighbouring districts of Land's End, Gwinear, Camborne, and Redruth.

Wheal Penrose and Wheal Rose, Sithney.

(*Abandoned.*)

Wheal Penrose is situated about three-eighths of a mile north-west of Wheal Rose, and $2\frac{3}{4}$ miles south-west of Helston Station. The mines were amalgamated about the year 1842.

Maps.—One-in. New Series Ordnance and Geological, 359; 6-in. Cornwall, 76 S.W. H.O. Plan of Wheal Rose, No. R 195.

Memoir.—"The Geology of the Lizard," pp. 257–259.

The country rock consists of slates of the Mylor Series. The lode courses N. 20° W. for a distance of nearly a mile inland from Parc-an-als Cliff. Another lode courses nearly parallel and about 900 ft. to the east. The first lode was mined at Wheal Penrose, and the other at Wheal Rose.

According to Stephens,[1] Wheal Rose was worked during the Roman occupation of Britain. Wheal Penrose was mentioned by Borlase[2] in 1758, and by Joseph Carne[3] in 1818, who then stated that the mine was "wrought for lead upwards of two hundred and fifty years ago, and the produce was sold merely as lead ore," and that "its lead ore yielded sixty ounces of silver to the ton."

"In 1871 the Wheal Rose sett was 850 fathoms long from north to south and 300 fathoms in width, and comprised six lead lodes.

"Shafts were sunk to the 64-fathom level and the silver-lead ore extracted was sold for £100,000, on an average of £20 to £26 per ton. It appears to have been the miners' opinion that the main lode is that which is known as Wolf's cross-course in Wheal Vor, and which yielded copper ore in Godolphin Bridge Mine. The ore consisted of galena, with phosphate of lead, carbonate of iron, and quartz. Small vugs containing phosphate and arseniate of iron were found, while phosphate also occurred in parallel cracks in the country rock. The gossan consisted of brown hæmatite, which contained in places rich silver-lead.

[1] Stephens, H., *39th Ann. Rept. Roy. Corn. Poly. Soc.*, 1871, p. 77.
[2] "The Natural History of Cornwall," p. 211.
[3] *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 119, 120.

At the 54 fathom level an east and west cross-course headed the lode."[1]

According to Collins, Wheal Penrose was an important mine early in the 16th century. He states that "An agreement for working Wheal Penrose, made between Mr. Thomas Penrose . . . and Sir William Godolphin . . . bearing date 1625, is in the possession of Captain Rogers, of Penrose."[2] Collins (*op. cit.*) further states that "other lead mines worked in the Helston district were known as Wheal Unity and Wheal Saturn. These lodes yielded large quantities of blende, carbonate of iron, and iron pyrites, and the old workings above adit when re-opened . . . about 1870, were found to be beautifully coated with druses of pyromorphite."

Wheal Pool, Wendron.

(*Abandoned.*)

The mine is situated on the eastern side of the Loe Valley, about seven-eighths of a mile south of St. Michael's Church, Helston.

Maps.—One-in. New Series Ordnance and Geological, 359; 6-in. Cornwall, 76 S.W.

Memoir.—"The Geology of the Lizard," pp. 257, 259.

The country-rock consists of slates of the Mylor Series. The available information regarding the mine is very meagre. Joseph Carne,[3] writing in 1818, stated that it was worked for lead upwards of two hundred and fifty years ago and that "the produce was sold merely as lead ore. . . . About 1790, Huel Pool was again set at work, and produced lead-ore which yielded from thirty to forty ounces of silver per ton."

Smelting and testing works were erected for the extraction of silver from the lead-ore of this mine and of Wheal Rose.[4]

Wheal Sally (Wheal Lushington or West Wheal Towan), Illogan.

(*Active.*)

The Cornish Mining Syndicate, Finsbury House, E.C.

Shafts and levels situated nearly a mile south-west of Porthtowan Coastguard Station and 5 miles by road from Redruth Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 352; 6-in. Cornwall, 56 N.W. Wheal Lushington, H.O. Plan Nos. R 200 and R 201; West Towan, H.O. Plan No. R 54.

Memoir.—"The Geology of Camborne and Redruth," pp. 231, 232.

The country-rock consists of red and green slates, with beds of sandstone, of the Falmouth Series.

[1] "The Geology of the Lizard and Meneage" (*Mem. Geol. Surv.*), 1912, pp. 257–8.

[2] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 704.

[3] "On the Discovery of Silver in the Mines of Cornwall," *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 118–126.

[4] Carne, J., *Op. cit.*

The lode that was being developed in July, 1919, was called the Wheal Sally Lode. It courses E.N.E. and dips S.S.E. at 65° to 70°. Its average width is about 2 ft. The principal ore is blende, but argentiferous galena and copper pyrites occur in bunches. The blende in proportion to galena is as 10 to 1. The gangue consists of quartz with some "peach," and (above adit level) of brecciated slate cemented with quartz. There are four other lodes said to contain ores of lead and zinc. The lead lode as seen in the cliff at adit level is 2 ft. wide. It yielded lead- and tin-ore with mundic.[1] Three other lodes are mentioned in this memoir at West Wheal Towan, while nine lodes are shown on two sections of Wheal Lushington.[2]

The adit level lies at 22 fthms. below the surface. There is a shaft with winding gear down to 30 fthms.; it meets the lode at a depth of 20 ft. below grass.

The mine is dry.

Nancekuke or Wheal Clarence, Illogan.

(Idle.)

Shafts situated at Porthtowan on the western bank of the stream. The mine lies about 5 miles by road from Redruth Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 352; 6-in. Cornwall, 56 N.E. Nancekuke, H.O. Plan No. R 77.

Memoir.—"The Geology of Camborne and Redruth," pp. 256, 292.

The country-rock is greenish slate of the Falmouth Series.

The lead lode courses N.N.W. for a quarter of a mile and then turns nearly due north. It underlies a little south of west, intersects many lodes bearing tin- and copper-ores, and has been worked from five shafts. Adit level at the South Shaft lies at a depth of 44 fthms. from the surface. A longitudinal section of the lode is shown in Fig. 1. It is presumably this

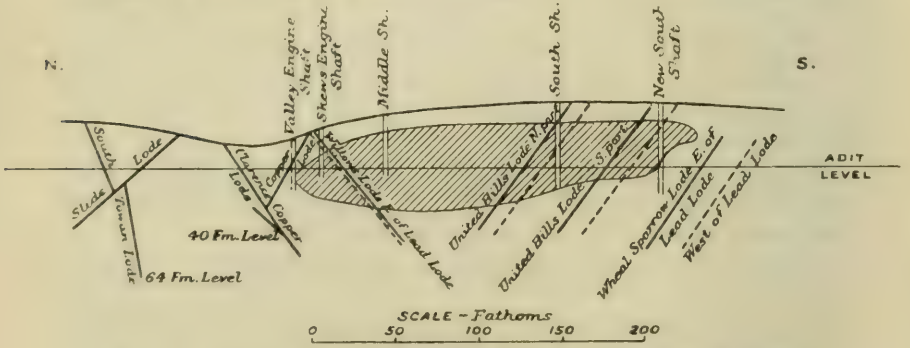


Fig. 1.—*Nancekuke Mine (Wheal Clarence); Longitudinal section of Lead Lode.*

[1] "The Geology of Camborne and Redruth" (*Mem. Geol. Surv.*), 1906, p. 254.

[2] *Op. cit.*, pp. 231, 232.

lode that was described by Pryce in the following words :—"In searching for copper-ore in Nanskuke Downs, in a very promising Gossan, we discovered a leader, 6 ins. wide, of very rich lead of the antimoniated kind upon the north wall of the lode. The silver in it was plenty, insomuch as to render the mineral worth £18 or £20 per ton without any dressing. It produced about a ton and a half, and then totally disappeared."[1]

Some time between the years 1848 and 1905 the mine had an output of lead-ore amounting to 747 tons, which contained 505 tons of lead and 13,709 ozs. of silver.[2]

Sundry Minor Occurrences.

Ores of silver-lead and zinc have been raised in small quantities from several mines situated in West Cornwall. The following mines each had an output of over 50 tons. The amounts yielded are estimated from details published in official records between 1854 *and* 1907, *but cannot be considered as complete.*[3] *The mines fall within the area of the* 1-*in. New Series Maps* 351 *and* 358 (*Penzance*).

Mine.	Parish.	Six-inch Map (Cornwall).	Output in Tons.		Remarks.
			Lead Ore.	Zinc Ore.	
Boiling Well -	Phillack -	62 S.W.	410*	54	* Nearly 5,000 ozs. of silver obtained.
Emily, Wheal -	Gwithian	62 N.W.	75	25	
Prosper United -	St. Hilary	69 S.W.	60†	—	† Nearly 200 ozs. of silver obtained.
Violet Seton -	Camborne	62 N.E.	56	212	
West Roskear -	Camborne	62 S.E.	48	350	105 ozs. of silver-ore.
Arthur, Wheal -	Phillack	—	—	160	
Alfred, Wheal, and Alfred Consols	Phillack	69 N.W.	—	245	
Carpenter, Wheal	Gwinear	69 N.E.	—	80	
Gill, Wheal -	St. Ives	—	—	200–300	1820 to 1830.
Mellanear - -	St. Erth	69 N.W.	—	1,400	
Rosewarne and Herland	Gwinear	69 N.E.	—	110	Nearly 9,000*l.* worth of silver-ore before 1814. Since 1854, 106 ozs. of silver-ore obtained.

[1] Pryce, W., "Mineralogia Cornubiensis," London, 1778. p. 58.

[2] "The Geology of Camborne and Redruth" (*Mem. Geol. Surv.*), 1906, p. 292.

[3] *See* "The Geology of the Land's End District" (*Mem. Geol. Surv.*), 1907, pp. 133–4.

Carne[1] remarks that at Herland Mine " the silver was found in a cross-course, or north and south lode, and was richest near the point where this lode intersected the copper lode, particularly where the latter was rich in copper-ore. It was discovered in the 90, and continued to the 120 fathoms level. Its extent in length was nowhere above 45 ft., but it gradually became poorer as its distance from the copper lode increased. The ore consisted chiefly of vitreous silver-ore, arsenicated silver-ore, and black oxyde of silver. Some of the latter, called by the miners *goose-dung* ore, contained upwards of 50 per cent. of silver." He records that at Huel Ann, Phillack, a " small bunch of blackish grey silver-ore, containing a great deal of arsenic and spathose iron, and accompanied by native silver, was found in the sixty-five fathoms level, in an east and west copper lode. In the seventy-five fathoms level, the silver-ore appeared in the midst of the copper lode, as a separate lode, from two to five ins. wide, between distinct walls of quartz."[2]

In 1903, 21,000 ozs. of silver-ore were raised at Wheal Trebarvah, Perranuthnoe; and in 1905, 3,440 ozs. of silver were obtained from 14 tons of silver-ore at the Perran Mine near Marazion.[3]

The greatest recorded quantity of silver-ore was obtained at West Wheal Darlington (The Bog Mine) in Ludgvan (*Maps.*—One-in. New Series 351 and 358; 6-in. Cornwall, 68 S.E.; H.O. Plan No. R 208, 1855). There are two lodes, one coursing W. 20° N., and the other W. 10° S. The first underlies south-west from 54° to 74°, and the second south from 30° to 76°. The lodes contained iron and copper pyrites, mispickel, blende, cassiterite and stannite. The mine " unexpectedly yielded large masses of native silver mixed, sometimes, with galena, and, less frequently, with copper pyrites."[4]

The silver-ore was obtained between 1852 and 1855, and amounted to 351½ tons.

Small quantities of lead- and silver-ores have been raised in the Camborne district. At Dolcoath (*Maps*—1-in. New Series, 352; 6-in. Cornwall, 63 S.W.) a nearly vertical lode coursing parallel with the main lode yielded silver-ore at about the 160-fthm. level; it also contained some cobalt-ore. Collins records the quantity of silver-ores sold during 1810, 1833, 1858, 1859 and 1860 at about 356 tons.[5] Of this amount, 120 tons came from Dolcoath and the remainder from North Dolcoath. According to Garby " argentiferous arsenical iron . . . has been found, both massive and crystallised, at Huel Providence,

[1] Carne, J. " On the Discovery of Silver in the Mines of Cornwall," *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 121, 122.

[2] *Op. cit.*, p. 124.

[3] " The Geology of the Land's End " (*Mem. Geol. Surv.*), 1907. p. 134.

[4] Henwood, W. J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, pt. 1, 1871, pp. 116 7 and *ibid*, Vol. V, 1843, Table XXIV and Plate iii.

[5] " The Precious Metals in the West of England," *Journ. Roy. Inst. Cornwall*, Vol. XVI, 1904, pp. 113, 119.

in Gwinear; and at Huel Mary, near Redruth; at the latter locality it is associated with cobalt-ores."[1] In 1827, Treskerby and North Downs, near Redruth, yielded small quantities of silver-ore; and about half a ton was obtained in 1878 at Treleigh Consols.[2] Some silver-ore was got from a cross-course at Wheal Basset, Illogan, at 38 fthms. below the surface. "Some of the grey ore yielded 600 ozs. to the ton; it is worthy of notice that the galena associated with this ore was not itself rich in silver."[3] Ores of lead and silver have been raised in the parishes of Kea and Kenwyn, especially in the Jane and Falmouth Mines. At North Jane a lead lode was worked to the 10-fthm. level, the output of silver-lead-ore in 1864 being 51½ tons. Wheal Jane produced 203 tons of lead-ore containing 2,921 ozs. of silver, and 586 tons of zinc-ore; while East Wheal Falmouth yielded 413 tons of lead-ore with 17,100 ozs. of silver, and 487 tons of zinc-ore. The Swanpool Mine in 1859 and 1860 had an output of 895 tons of lead-ore with 3,579 ozs. of silver.[4]

II.—The Newquay District.

This district (*see* map, Plate I) embraces the area lying between Truro and Newquay and includes some of the richest lead-bearing country in the West of England. It is remarkable that most of the rich lodes in this district do not course north and south, but either north-east and south-west, or nearly east and west. The series of highly productive lodes worked in the Chiverton Mines course nearly parallel with the group that were for many years exploited with success at East Wheal Rose, Cargoll, and Old Shepherds Mines. The country-rock is killas, belonging to the Ladock Beds of the Lower Devonian.

The remarkable Great Perran Lode was the principal producer of zinc-ore in Cornwall and Devon. It courses for many miles nearly east and west and contains iron-ores near the surface. Here the country-rock consists of the calcareous slates (Meadfoot Beds) of the Lower Devonian.

All the mines are flooded, but none is deeper than 200 fthms. It is, however, the opinion of many local miners that the ores of lead and zinc are to a great extent exhausted.

West Chiverton, Perranzabuloe.

(*Idle. Dumps being worked.*)

Shafts situated one mile and seven furlongs west of St. Allen, and nearly four miles by road from Shepherds Station (G.W.R.).

[1] Garby, J., "A Catalogue of Minerals found in Cornwall," *Trans. Roy. Geol. Soc. Cornwall*, Vol. VII, 1848, p. 82.

[2] Collins, *op. cit.*, pp. 115, 117.

[3] Collins, *op. cit.*, p. 114.

[4] "The Geology of Falmouth and Truro" (*Mem. Geol. Surv.*), 1906, pp. 290–95.

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.E. H.O. Plan Nos. R 163, 1,471 received at H.O. in 1883, and 1,950 received in 1886.

Memoir.—" The Geology of Newquay," pp. 104, 108, 110, 115, 119.

The country-rock consists of soft shaly slates of the Ladock Beds where the lodes were productive and of hard sandstones and grits where the ores became impoverished (*see* Plate III). The beds dip south-west and the shoots of ore inclined in the same direction. According to the above-mentioned plans of the mine, the principal lodes were the North Lode and the South Lode. Other lodes worked were Williams's, Valpy's, and Elizabeth's, and a small Middle Lode. The North and the South Lodes course nearly parallel and E. 27° N. The North Lode underlies south-east at 2 in 1, and the South Lode at 3 in 1.

There were five shafts on the South Lode known as Glubb's, Batter's, Burgess's, Hawkes's and Susanna's Shafts. Susanna's Shaft is 80 fthms. deep; adit level is at 10 fthms., and there are levels at 10 fthm. intervals down to the 70-fthm.

At Hawkes's Shaft the first level lies at 40 fthms. below adit and other levels at every 10 fthms. down to the 140-fthm. At Burgess's Shaft there is no adit, the first level is at 40 fthms., the second at 70, and below that at every 10 fthms. down to the 120-fthm.; the 130-, 140-, and 150-fthm. levels are connected with Batter's Shaft, where the levels occur at 10-fthm. intervals between the 60- and the 170-fthm. At Glubb's Shaft there are seven levels between the 70- and the 150-fthm. levels. The lode was largely stoped away between the 60- and the 160-fthm. levels for a distance from west to east of 250 fthms. The ore body inclined to the south-west following the cleavage dip of the killas, and was rich in the slate, but impoverished or barren in the sandy beds. Williams's Lode courses nearly north-east, underlies to the south-east at 1 in 3, and ranges from 2 to 6 ft. in width. Valpy's Lode is a southern branch of Williams's Lode; it leaves the hanging-wall of the latter at a depth of 50 fthms., and rejoins it between the 90- and 100-fthm. levels, thus enclosing a large " horse " which was nearly 100 fthms. long.[1] The lode is more compact than Williams's Lode, and the galena occurred more often in solid and massive leaders. It is from 1 to 3 ft. wide.

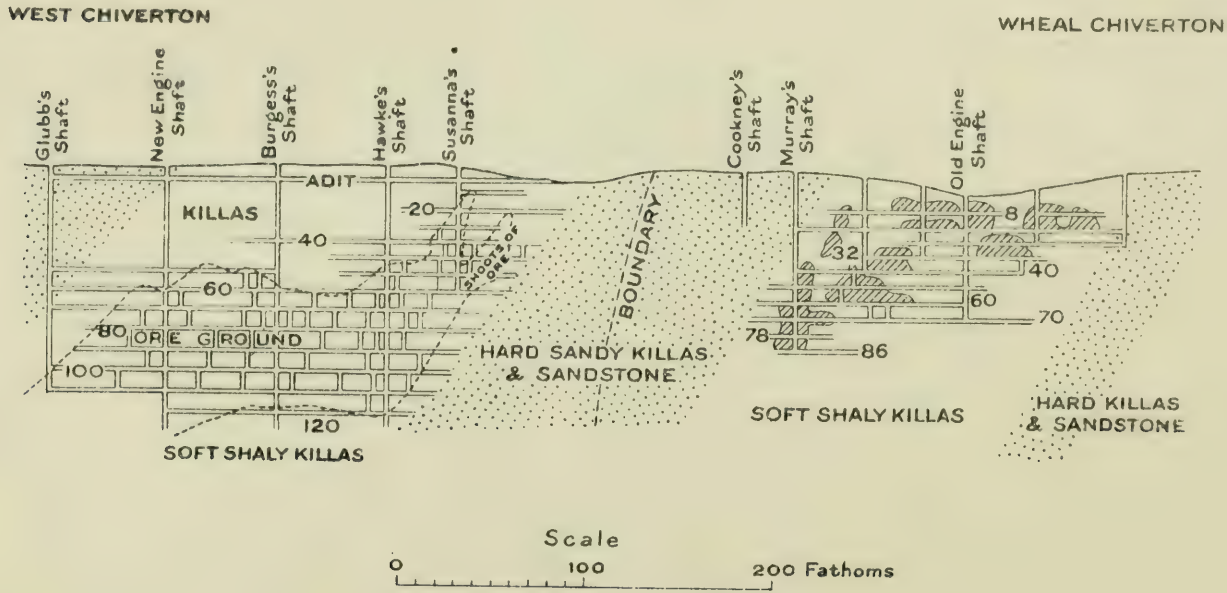
Elizabeth's Lode courses parallel with Valpy's but has a greater underlie. It lies north of Williams's Lode and forms a junction with it at about 80 fthms. in depth. It is of a more " flucany " or clayey character, contains rich silver-lead ore,[2] and varies in width from 1 to 3 ft.

Collins (*loc. cit.*) says " the ' back ' of Williams's Lode was sparry to a depth of 40 fathoms from the surface, where the great ore-shoot was first seen in the bottom of the level as a small

[1] Collins, J. H. " Lead-bearing Lodes of the West," *op. cit.*, p. 702.
[2] Salmon, *Mining and Smelting Magazine*, Vol. V, 1864.

PLATE. III.

SECTION ON LINE OF WEST CHIVERTON AND WHEAL CHIVERTON MAIN LODES.



'pipe' of ore in the lode, which rapidly spread out until at the 90 it was 200 fathoms long. At this level the workings presented a very fine aspect. Stopes of 27 ft. wide were being removed . . . the back showed a series of veins of galena, blende, and quartz, each of which carried in places a rich leader of 12 to 16 ins. in width. This great size and richness was thought to be due to the coming together of the three lodes."

The plan (Plate III) of the workings is copied from that published by J. H. Collins (*op. cit.*, Plate II).

The mine was extensively worked down to the 120-fthm. level. Collins[1] was of opinion that the shoots of ore "might have been profitably followed to far greater depths than were attained when the mines stopped," but the present owners state that "by the old miners the ground is said to be exhausted for lead, but some reserves of blende probably remain." The water in the mine is heavy. There are extensive dumps which were being worked in 1919 for lead- and zinc-ores. The waste consists of three sorts of material. The first is large fragments of gangue and country-rock containing much blende which was reworked 30 years ago; the second is a yellow quartzose gravel containing hardly any tailings of blende or galena; the third sort consists of tailings composed almost exclusively of grains of blende which were formerly irrecoverable, or not worth recovering at the time when the mine was worked for lead. These are now described as the "pay dirt." It is everywhere covered with an overburden of quartzose sand without blende, and rests upon the grass. It varies in thickness in the dumps and has been proved in a series of 4-in. boreholes put down at every 25 ft. over a total footage of 1,600 ft. Some seams are rich while others contain much quartz and waste, but both repay costs of mining and treatment. Only the blende is required, but as it is associated with a small proportion of galena, "mundic" and mispickel, these are separated on James tables, and the mixed galena and pyrites put by in case of future demand. The water draining from the dumps shows on analysis appreciable quantities of both lead and zinc. Among the refuse there are many examples of partly dissolved crystals of both galena and blende, and of negative crystals of both minerals. The former percolation of ground-water must have led to secondary enrichment at depth, but no accounts of the nature of the minerals found have been preserved. In 1919 the following treatment of the ore was employed, but an oil flotation plant was being installed. The ore in the bin contains 10 per cent. of metallic zinc. It is passed successively through a disintegrator, an elevator and a classifier, where it is divided into spigot and overflow. The spigot is again classified, and it and the overflow are treated on separate slime tables, where the zinc concentrate is raised to 38 per cent. The overflow from the third classifier is treated on buddles, where the concentrate is raised to 20 per cent.

[1] *Op. cit.*, p. 704.

of zinc. In practice it is found that the 10 per cent. stuff of the bin yields 75 per cent. of its metallic zinc, the remaining 25 per cent. being lost.

The output between 1859 and 1887 from West Chiverton according to the Mineral Statistics was as follows :—lead-ore, 45,100 tons; metallic lead, 32,650 tons; silver, 1,221,200 ozs.; zinc-ore, 22,000 tons; the zinc-ore raised between 1881 and 1883 yielded 35 to 50 per cent. of zinc.

The present output of zinc-ore with 37 per cent. zinc averages about 280 tons per annum.

Reserves.—There are estimated to be upwards of 7,000 tons of " pay-dirt " remaining in the dumps.

Wheal Chiverton (Cornubian Mine), Perranzabuloe.

(Idle.)

Shafts situated about 1½ miles west-north-west of St. Allen Church and 4 miles by road from Shepherds Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.E. H.O. Plans Nos. R 37, R 304; Chiverton East, 1,627, received at H.O. in 1884, and R 73 received in 1879.

Memoir.—" The Geology of Newquay," pp. 95, 116.

The mine is known also as Old Chiverton and Ventongimps.

The lodes were worked under Chiverton House, which at one time was the count-house of the mine. Chiverton East Mine is on the supposed extension of the West Chiverton lodes and was worked to a depth of 55 fathoms.[1]

The country-rock consists of soft shaly killas where the lodes are productive and hard sandstone and grit and fine conglomerate where they become impoverished.

The lodes worked at this mine are apparently a continuation of the Williams's, Valpy's and Elizabeth's Lodes of West Chiverton Mine[2] (*see* p. 15). When the mine was abandoned the eastern part was poor (*see* Plate III), but westwards at the 78- and the 86-fthm. levels the ore-ground was good[3]. " The mine was only sunk to a depth of 86 fathoms and large stopes were worked away. It is said that lead-ore to the value of over 100,000*l.* was obtained, although there was a considerable loss."[4]

The recorded output for Wheal Chiverton between 1866 and 1872 was 850 tons of lead-ore, 640 tons of lead and 22,120 ozs. of silver. For East Chiverton (a part of Wheal Chiverton) between 1870 and 1883 the output was 350 tons of lead-ore, 250 tons of lead, 4,080 ozs. of silver, and 915 tons of zinc-ore. In 1873 the zinc-ore contained 45 per cent. of zinc.

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[1] Collins, J. H., " The West of England Mining Region," 1912, p. 447.
[2] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 704.
[3] Salmon, H. C., *Mining and Smelting Magazine*, 1864, Vol. V, p. 272.
[4] Collins, *op. cit.*, p. 703.

Chiverton Moor (formerly Great Callestock Moor), Perranzabuloe.

(*Idle.*)

Shafts situated about one and a third miles south-east of Perranzabuloe Church and two and a quarter miles by road from Mithian Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.W. H.O. Plans Nos. R 298 and 46, deposited at H.O. in 1869 and 1873 respectively.

Memoir.—"The Geology of Newquay," pp. 107, 109, 116.

The country-rock consists of the finely cleaved grey shales with some beds of grit (Ladock Beds) of the Lower Devonian.

Collins[1] states that the mine is an old one that re-opened in 1863; in 1864 it had reached the 30-fthm. level (no adit); and by 1870 it was 85 fthms. deep, but it had no great success. There were two nearly parallel lodes coursing north-east, and underlying south-east.

The output between 1866 and 1873 was 2,130 tons of lead-ore containing 1,600 tons of lead and 24,000 ozs. of silver. In 1847, Great Callestock Moor sold 110 tons of lead-ore.

The mine is flooded.

Chiverton, Great South, Perranzabuloe.

(*Idle.*)

Shafts situated about 2 miles west-south-west of St. Allen Church and 3 miles by road from both Mithian and Shepherds Stations (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.E. H.O. Plans Nos. 119 and R 38, deposited at H.O. in 1874 and 1871 respectively.

Memoir.—"The Geology of Newquay," pp. 107, 110, 118.

The country-rock consists of grey shales and grits (Ladock Beds) of the Lower Devonian.

There are three lodes which course nearly parallel and to the north-east. They underlie south-east.

Collins[2] states that the mine commenced work in 1864; by 1870 it was 60 fthms. deep (no adit). It yielded galena, blende, copper-ore and pyrites, but never in important quantities. On the plans at the Home Office, levels are shown at adit and at 20, 30, 40, 50 and 60 fthms. below adit.

The output for South Chiverton and South Great Chiverton between 1867 and 1873 was 160 tons of lead-ore containing 120 tons of lead and 3,900 ozs. of silver.

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[1] and [2] "The West of England Mining Region," 1912, p. 447.

Chiverton, New, or Chiverton New Consols, and Old Wheal Anne, Perranzabuloe.

(Idle.)

Shafts situated beside the railway one-third of a mile north of Perranzabuloe Church, and about one and a half miles by road from Perranporth Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.W.

Memoir.—" The Geology of Newquay," pp. 107, 109, 118.

The country-rock consists of the black and grey silty shales (Ladock Beds) of the Lower Devonian.

The principal lode courses nearly north and south and underlies to the east. It is intersected at right angles by a cross lode underlying south.

In 1864 the mine was 50 fthms. below adit (3 fthms.). It closed down about 1879.[1]

The output between 1864 and 1878 was 300 tons of lead-ore containing 220 tons of lead and 1,300 ozs. of silver, and 640 tons of zinc-ore.

Chiverton, North, Perranzabuloe.

(Idle.)

The site of the mine is said by Collins to be to the north-east of West Chiverton, but not very near.[2]

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 S.E. H.O. Plan No. R 197, deposited at H.O. in 1869.

Memoir.—" The Geology of Newquay," pp. 106, 118.

If the mine is the abandoned one near Honeycomb the country-rock consists of the Ladock Beds of the Lower Devonian.

The accompanying sections (Fig. 2) of the mine are taken

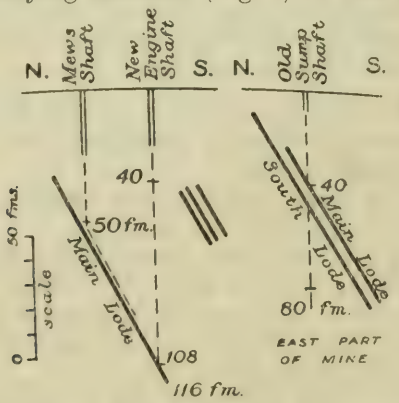

Fig. 2.—*North Wheal Chiverton. Cross sections.*

[1] Collins, J. H., " Observations on the West of England Mining Region," 1912, pp. 447, 448.

[2] " The West of England Mining Region," 1912, p. 448.

from the above-mentioned memoir. There are two parallel lodes, the Main Lode and the South Lode, which both underlie south at about 45°. Collins states that it was "a large lode but poor."[1] In 1864 the mine was 10 fthms. below adit (adit 27 fthms.); in 1867 it had reached a depth of 80 fthms. Some bunches of lead-ore were found.

Between 1864 and 1868 the output was 100 tons of lead-ore containing 75 tons of lead and 3,640 ozs. of silver; also 630 tons of zinc-ore.

Albert, Wheal, Perranzabuloe.

(*Idle.*)

Shafts situated a few yards east of Goonhavern Halt (G.W.R.), and a little over 2 miles east of Perranporth.

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.E. H.O. Plan No. R 287, deposited at H.O. in 1867.

Memoir.—"The Geology of Newquay," pp. 107, 109, 116.

The country-rock consists of the black and grey soft silty slates (Ladock Beds) of the Lower Devonian.

There appear to be three lodes coursing nearly east and west and underlying south. Collins[2] states that in this mine there are also extensions of the North and South Lodes of Wheal Peru, and that large quantities of lead and blende are said to have been raised.

There is no adit, but levels at 25, 35 and 48 fthms., and there are five shafts.

The mine is flooded.

The output in 1852 and 1854 was 40 tons of lead-ore yielding 30 tons of lead and 70 ozs. of silver.

Cargoll, Newlyn East and St. Erme.

(*Idle.*)

Shafts situated on Newlyn Downs, about one mile east of Shepherds Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.E. H.O. Plan of South Cargoll, No. R 70.

Memoir.—"The Geology of Newquay," pp. 107, 109, 111, 112, 116.

The country-rock consists of the grey and black shales and pink grit (Ladock Beds) of the Lower Devonian, with some veins of mica-trap.

The lode courses a little east of north and was sunk on for a distance of two-thirds of a mile. There is a good deal of blende on the dumps. The gangue is quartzose.

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[1] "The West of England Mining Region," 1912, p. 448.

[2] "The West of England Mining Region," 1912, p. 400.

According to Collins[1] the adit level is 22 fthms. from grass, and in 1864 the mine was 120 fthms. below adit. In 1870 the workings were down to 185 fthms. An attempt to re-work the mine about 1891 did not succeed.

Between 1845 and 1884 the output of lead-ore amounted to 14,000 tons, containing 9,800 tons of lead and 177,400 ozs. of silver. Between 1864 and 1885, 3,600 tons of zinc-ore were obtained.

East Wheal Rose, Newlyn East.

(Idle.)

Shafts situated on the eastern side of the River Allen, near Shepherds Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 49 N.W. H.O. Plan Nos. R 87 and 1949, deposited at H.O. in 1886.

Memoir.—" The Geology of Newquay," pp. 96, 97, 107, 109, 112, 117.

The country-rock consists of the dark-grey and black shales (Meadfoot Beds) of the Lower Devonian.

The lodes course north and south and underlie both east and west. On the sections (Fig. 3) and on Plate IV the names of the lodes and the shafts are given. Purser's Shaft lies to the north of the Carbis and Michell shafts. It is noticeable that the lodes unite at depth in the centre of the mine.

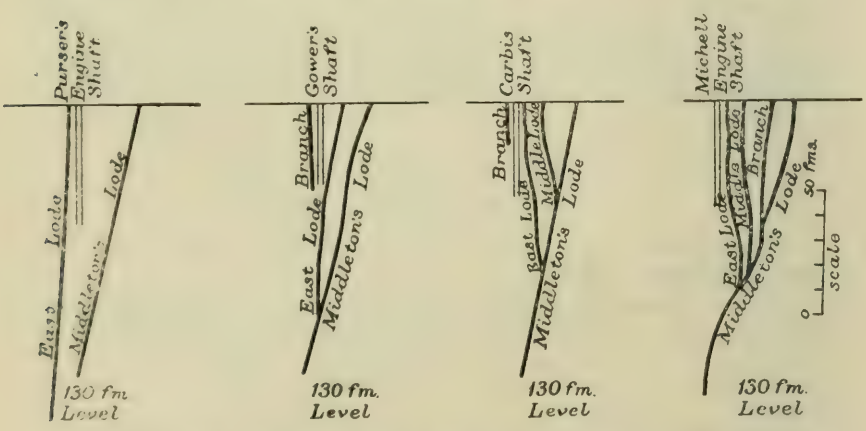


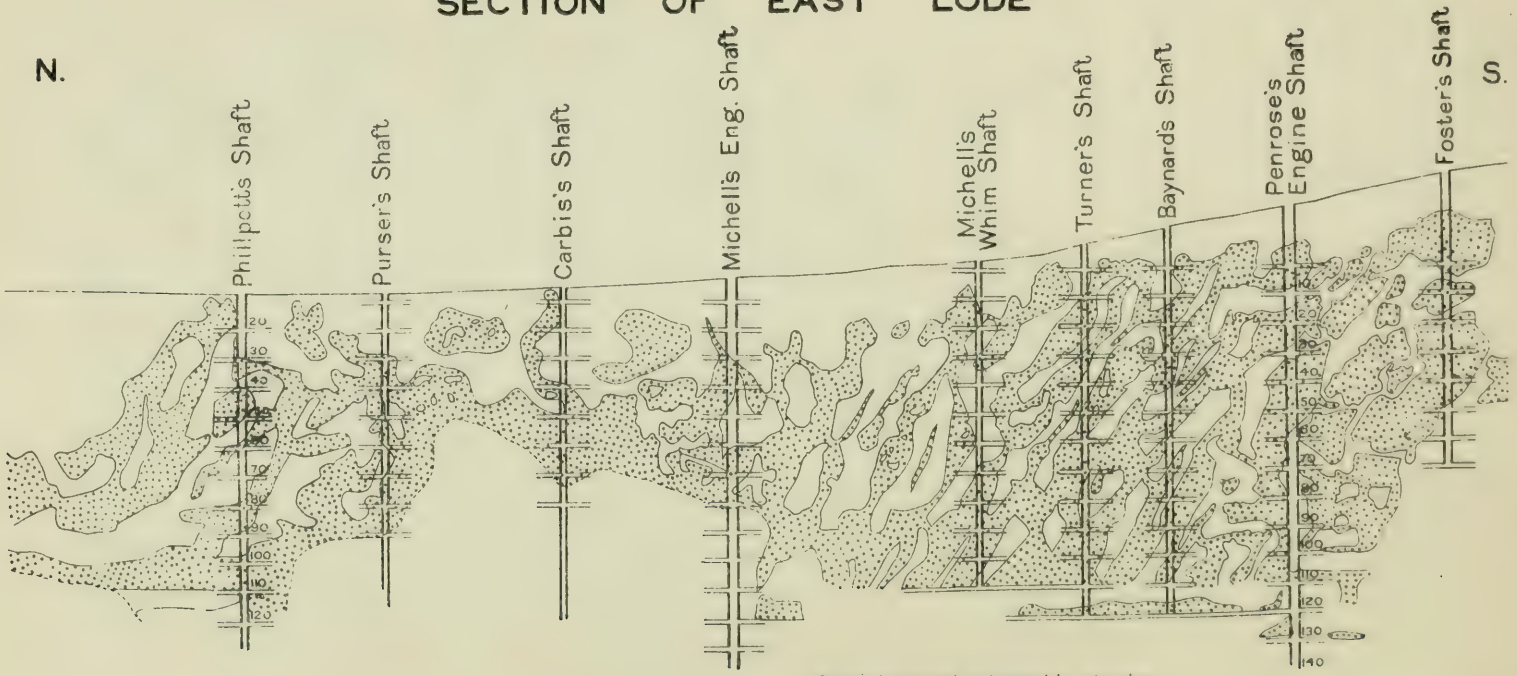
Fig. 3.—*East Wheal Rose. Cross sections.*

The north and south lodes are intersected almost at right angles by the Shepherd's Lode. Of this W. J. Henwood states: " a *lode* and *cross-vein* meet nearly at right angles, and are almost equally productive of lead ore for many fathoms on either side

[1] " The West of England Mining Region," 1912, pp. 437–8.

PLATE. IV.

EAST WHEAL ROSE
SECTION OF EAST LODE



Stoped ground indicated by stipples.
Depths given in fathoms.

of the point of contact; a case, as far as I know, without a parallel in Cornwall."[1]

Collins remarks that northward from this junction the north and south lode continued to be productive for a long distance; but southward, it soon deteriorated. "A great part of the main lode consisted of 'sandy' or 'running' ground, so that it was often necessary to keep the 'ends' closely boarded up to allow the loose ore to flow out into a bucket through a narrow opening."[2]

In 1848 W. W. Smyth stated that "at the exceedingly productive mine of East Huel Rose in Cornwall, not only is the 'killas' very soft, but the lode itself, including its saccharoid quartz or 'sugary spar' is in so disintegrated a condition, that a blow with a pick will often cause it to run down like a quantity of sand and mud."[3]

Between 1845 and 1885 the output of lead-ore amounted to 48,200 tons containing 29,680 tons of lead, and 212,700 ozs. of silver. There were also some 280 tons of zinc-ore containing 30 to 45 per cent. of metallic zinc.

From 1834 to 1855 the ores sold realised more than three-quarters of a million sterling. In 1842 a great cloud-burst flooded the mines and drowned forty of the miners. The mine did not make any profit after 1855 although it was re-opened in 1855 and in 1881. The ores of lead and zinc obtained between 1882 and 1886 came partly from the shallow levels and partly from the dumps.[4]

Shepherds Mine, Newlyn East

(afterwards part of the Shepherds United Group).

(*Idle.*)

Shafts situated immediately south of Shepherds Station (G.W.R.). They extend in a southerly direction along the lode for a distance of half a mile.

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.E. Old Shepherds, H.O. Plan No. R 77.

Memoir.—"The Geology of Newquay," pp. 100, 107, 109, 118.

The country-rock consists of the pink and light-green silty slates and grits (Ladock Beds) of the Lower Devonian.

The lode courses nearly north and south.

The gangue is quartzose.

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[1] "On the Metalliferous Deposits of Cornwall and Devon," *Trans. Roy. Geol. Soc. Cornwall*, 1843, Vol. V, p. 268.

[2] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 699–700.

[3] (*Mem. Geol. Surv.*, Vol. II, part 2), 1848, p. 667.

[4] Collins, *op. cit.*, pp. 700, 701.

A very ancient mine with no records of its early production which is said to have been large.[1] The mine was worked to a considerable depth.[2]

The output from 1853 to 1885 amounted to 430 tons of lead-ore and 175 tons of low-grade zinc-ore.

The Great Perran Lode, called also the Perran Iron Lode.

This lode courses in a general direction of a little south of east for many miles from the coast near Ligger Point, about four miles south-west of Newquay, inland to near Fiddler's Green. "Some of the north and south silver-lead lodes which occur in the district are seen in a few of the mines situated on the iron lode. Thus the Wheal Golden and Penhale silver and lead lode is said to traverse the iron lode at the cliff. The lead lode (containing horn and native silver) of Wheal Mexico is seen in Treamble. There are lead lodes at Great Retallack. The Peru and Wheal Hope Lodes are seen in Duchy Peru. In Deerpark the Shepherds lode is seen and at Penhallow Moor the Cargoll lodes."[3]

"Each of the great Treamble excavations is crossed by a very promising lode of 'silver lead,' the lodes Nos. 1 and 2 of the Great Retallack Mine adjoining to the north and east. Nothing has been done to develop these lodes for many years, but in working the iron ore of the outcrop some 60 or 70 tons of lead ore were obtained, which contained from 15 to 30 ozs. of silver per ton."[4]

At Great Retallack (p. 25) and Duchy Peru (p. 25) the largest quantities of ore were obtained. At Treamble there is an output recorded of 32 tons of lead-ore carrying 24 tons of lead and 130 ozs. of silver; also 7 tons of zinc-ore containing 40 per cent. metallic zinc. Galena was proved to occur at a depth of 7 or 8 fthms.

At the Mount and Trebisken Mine the Great Perran Lode is intersected by the Trebisken and Trebellan Lodes which contain sprigs of silver with galena. At about 20 fthms. from the point of intersection with the Trebellan Lode a rich deposit of native silver with galena was found. The recorded output from this mine is $5\frac{2}{3}$ tons of silver-lead ore, and some native silver raised from a caunter load.[5]

The further working of these lodes depends largely upon the possibility of winning the ironstone at commercial rates.[6]

J. H. Collins and W. W. Smyth were both of opinion that the lode may pass in depth into a copper lode.

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[1] Collins, J. H., "The West of England Mining Region," 1912, p. 579.
[2] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903. p. 698.
[3] "The Geology of Newquay" (*Mem. Geol. Surv.*), 1906, p. 100.
[4] Collins, J. H., "The West of England Mining Region," 1912, p. 229.
[5] "The Geology of Newquay," p. 98.
[6] *See* "Special Reports on the Mineral Resources of Great Britain" (*Mem. Geol. Surv.*), Vol. IX, 1919, p. 63.

Great Retallack, Perranzabuloe.

(*Idle.*)

Shafts situated about half a mile west-south-west of Rejerrah and two miles by road from Goonhavern Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-inch Cornwall, 48 N.E. H.O. Plan No. 4151. Abandoned about the year 1883.

Memoir.—"The Geology of Newquay," pp. 97, 100, 101, 107, 109, 117.

The country-rock consists of grey shales (Meadfoot Beds) of the Lower Devonian. There are masses of actinolite rock, containing at times, lumps of galena, lying scattered about on the surface near St. Stephen's Shaft.

The lode is the Great Perran Lode. It is several fathoms in width and at the 60-fthm. level is said to be 240 ft. wide.

Near the surface it contained brown hæmatite and blende, and the latter becomes of more importance with increasing depth. Near its intersection with the Peru Lode it contained rich argentiferous lead-ore. Below the 60-fthm. level copper-ore was found.[1]

Between 1858 and 1880 the output of lead-ore was 200 tons containing 150 tons of lead and 600 ozs. of silver. Zinc-ore amounted during this period to 11,500 tons, and there was also an output of one and a half tons of very rich silver-lead-ore. Collins states that "in some months 500 tons of blende have been raised and sold from here, and the total output must have been many thousands of tons," and that "in 1860–1 large quantities of blende were raised and sold, but at very low prices: from October to June in the latter year the sales were nearly 5,000 tons."[2]

Duchy Peru Mine, Perranzabuloe.

(*Standing.*)

Shafts situated about a third of a mile south-west of Rejerrah, and one and three-quarter miles by road from Goonhavern Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.E. H.O. Plan No. R 23.

Memoir.—"The Geology of Newquay," pp. 96, 100, 107. 109, 116.

The country-rock consists of the grey shales (Meadfoot Beds) of the Lower Devonian.

The Peru Lead Lode has been worked on down to a depth of 50 fthms. It is only a few inches wide. Its lead-ore contained 2,000 ozs. of silver to the ton, some of the silver being native.[3]

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[1] "The Geology of Newquay," p. 97.

[2] "The West of England Mining Region," 1912, p. 230.

[3] "Geology of Newquay," p. 96.

The Great Perran Lode at a few fathoms below the surface consists of " spathose carbonate of iron (with occasional broad belts of dark compact blende . . .) or of galena. On the whole the carbonate of iron is most abundant in the foot wall, the blende in the central or upper parts. In the wider portions of the lode the filling is a mass of breccia, enclosing large masses of carbonate of iron and of blende."[1]

The output of zinc-ore between 1858 and 1886 amounted to 20,000 tons. The ore contained from 20 to 47 per cent. of zinc, and for the best years averaged 45 per cent. There were also 185 tons of argentiferous copper-ore and 3 tons of lead-ore.

Collins says : " Of blende it is hard to say how much has been raised, though the output in the case of . . . Duchy Peru has been occasionally as much as 900 tons per month."[2]

Wheal Golden and Wheal Penhale, Perranzabuloe.

(*Idle.*)

Shafts situated near Penhale Point (Wheal Golden) and near Ligger Point (Wheal Penhale), and four miles by hilly roads to Newquay Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 39 S.W.

Memoir.—" The Geology of Newquay," pp. 18, 72, 81, 94, 95, 100, 107, 109, 117, 118.

The country-rock consists of dark-grey silty slates (Meadfoot Beds) of the Lower Devonian, and elvan dykes.

According to Pryce,[3] Wheal Golden was in 1778 " formerly " wrought under the sea. The lode courses N. 20° W. and " crosses a series of points and small bays in such a way as to be clearly seen in section in the cliffs and on the foreshore, the lode is vertical, or hades to the east, and it cuts the Perran iron-lode."[4]

This lode and the one at " the Phœnix Mine are veins having the same general bearing as cross courses and must be regarded as such."[5]

Penhale Mine according to Collins[6] is a very ancient mine, said to have been rich in its early days. In 1870 it was 135 fthms. deep.

W. J. Henwood states : " The vein on which Penhale and Wheal Golden were worked for Galena, bears 25° W. of N., dips E. 70–80°, and reappears in three or four of the small headlands. Its contents are mostly quartz and galena."[7]

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[1] Collins, J. H., " The West of England Mining Region," 1912, pp. 231, 232.

[2] *Op. cit.*, p. 232.

[3] " Mineralogia Cornubiensis," 1778, p. 21.

[4] " The Geology of Newquay," p. 81.

[5] *Op. cit.*, p. 94.

[6] " The West of England Mining Region," 1912, p. 547.

[7] *Trans. Roy. Geol. Soc. Cornwall*, Vol. V, 1843, p. 108.

The recorded output at Wheal Golden and Golden Consols between the years 1849 and 1855 amounted to 2,560 tons of lead-ore, yielding 1,570 tons of lead and 24,200 ozs. of silver. Penhale Mine from 1849 to 1870 had an output of 1,270 tons of galena containing 885 tons of lead and 7,150 ozs. of silver.

Wheal Phœnix, Perranzabuloe.

(*Idle.*)

Shafts situated near Ligger Point, one and a third miles west of Cubert Church.

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 39 S.W. H.O. Plan No. A 322, deposited at the H.O. in 1874.

The country-rock consists of hard grey slate (Meadfoot Beds) of the Lower Devonian. According to the above-mentioned plan the lode courses a little west of north and underlies east at 75°. There were two shafts, and levels at 20, 30, 40, 50, and 60 fthms. Most stoping was done at the 30-, 40-, and 50-fthm. levels, and more to the south of the shaft than to the north. There was ore at the 60-fthm. level.

Budnick Consols, Perranzabuloe.

(*Idle.*)

Shafts situated about a mile by road east-north-east of Perranporth Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.W.

Memoir.—"The Geology of Newquay," pp. 56, 75, 87, 94, 107, 109, 112, 116.

The following notes are from Henwood[1]:—The "lead lode" courses E. 30° N., and in underlie varies from 70–80° N.W. at the 34-fthm. to 60–70° S.E. at the 74-fthm. level. In width it ranges from an inch to 2 ft. The country-rock consists partly of elvan and partly of slate (Ladock Beds) of the Lower Devonian. Its gangue is quartzose and contains in addition to fragments of the country-rocks, blende, galena and copper pyrites.

The Caunter Lode courses E. 35° S. and varies in underlie from vertical to N.E. 80°. It is from 2 to 4 ft. wide. The country-rock is principally elvan. The lode contains tin, blende, copper and iron pyrites and galena. A lode which is believed to be the vein at Wheal Golden that yielded so much galena, forms a cross-course in this mine striking in a north-westerly and south-easterly direction but consists of quartz only. It is faulted 6 ft. by the Lead Lode.

The Lead Lode was worked down to the 74-fthm. level in 1843. Its width at this depth was from one to one and a half feet,

[1] *Trans. Roy. Geol. Soc. Cornwall*, Vol. V, 1843, Table 83.

and it carried as its principal product oxide of tin which occurs at its junction with other small veins near cross-courses. Henwood remarks that galena and blende, and copper pyrites are often mixed with tin ore.

The recorded output of lead-ore between 1855 and 1861 was 300 tons, containing 215 tons of lead and 7,200 ozs. of silver. There was an output of 2,740 tons of zinc-ore carrying 40 per cent. metallic zinc. In 1903 the output was 9 tons of lead-ore, 234 ozs. of silver, and 9 tons of zinc-ore.

Alfred, Wheal (New Wheal Leisure), Perranzabuloe.

(*Standing.*)

Shafts situated one-sixth of a mile north-west of Bolingey and about one-third of a mile by road from Perranporth Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 346; 6-in. Cornwall, 48 N.W.

For the following information we are indebted to Mr. F. Marshall, the proprietor of the mine.

The country-rock consists of black slaty killas down to a depth of about 35 fthms. below which grey and pink sandy killas occurs. These beds all belong to the Ladock Beds of the Lower Devonian.

There are two lodes, the North or Main Lode and the South Lode. The North Lode courses 80° E. of N., underlies south at 1 in 3 and varies greatly in width. It is 6 ft. wide at the 54-fthm. level and carries values of zinc up to 12 per cent. over a width of 5 ft. The chief ores present at this level include copper and iron pyrites, blende, and some galena. The characteristics of the lode have been thought to indicate a change at depth from blende to copper-ore. In 1919, between the 15- and the 35-fthm. levels there was said to be over 10,000 tons of blende in sight, with an average value of 11½ per cent. of metallic zinc.

The South Lode courses in a similar direction to the North Lode, but swerves so as to unite with it at the 15- and the 54-fthm. levels below adit. There are also two lodes carrying tin which course south-west. Adit level at the main shaft is 13 fthms. below surface. The following distances of drivage from the shaft have been carried out. At the 15-fthm. level, 117 ft. west and 180 ft. east; 120 ft. along the north branch lode, and 125 ft. of cross-cuts. At the 25-fthm. level, 480 ft. west and 160 ft. east; 100 ft. on the north branch lode and 80 ft. of cross-cuts. At the 35-fthm. level, 460 ft. west and 140 ft. east. At the 54-fthm. level, 40 ft. west and 100 ft. east. The total development is as follows :—shaft, 186 ft.; levels on lodes, 2,030 ft.; winzes and rises, 650 ft.; cross-cuts, 340 ft.

Eleven thousand tons of ore were treated and 2,000 tons of blende sold. Four thousand tons of ore came from development

work. The ore milled averaged 14 per cent. of metallic zinc: the extraction being 60 per cent., or a loss of 40 per cent. Copper averaged ·08 per cent.

The zinc values on the assay plan showed, for levels west of the shaft, the following variations :—at the 25-fthm. level from 5·7 to 21·6 per cent., with an average of 11·8 per cent.; at the 35-fthm. level from 7·9 to 17·2 per cent., with an average of 12·2 per cent.

The levels to the east of the shaft showed the following assay values : at the 15-fthm. from 6·5 to 11·8, with an average of 9·2 per cent.; at the 25-fthm., from 3·6 to 28·6 with an average of 16·7 per cent.; at the 35-fthm. level from 1·8 to 12·5 with an average of 6 per cent.

The drainage waters flowing from the adit level of the adjacent St. George Mine at Perranporth carry sulphate of copper in solution. This was formerly precipitated on scrap iron. It has formed a cement of green carbonate of copper around the grains of sand at the old tailing dumps on the foreshore, which are now described as " greens."

The output for the years 1907 to 1911 amounted to 1,624 tons of zinc-ore which assayed from 30 to 50 per cent. and yielded 566 tons of metallic zinc.

Garras and Guarnek Mines, St. Allen.

(*Idle.*)

Guarnek and Garras are both about one and an eighth miles south-south-west of St. Allen Church.

Maps.—One-in. New Series Ordnance and Geological, 346 and 352; 6-in. Cornwall, 57 N.E.

Memoir.—" The Geology of Camborne and Redruth," p. 230.

The lead lode is indicated on the geological map, Sheet 352, coursing north in the Grampound Beds (Lower Devonian) from about a mile north of Kenwyn Church northwards into Sheet 346, a distance of nearly three-quarters of a mile. The lode, which varies in width from 2 to 6 ft., is heaved twice by slides. The ore richest in silver was found between these slides and about 70 fthms. from surface.[1]

MacAlister[2] states that " the lode runs N.N.E. and S.S.W. and is about 2½ ft. wide. It is heaved twice by two slides each of which throws the lode 6 fthms." Borlase quotes Dr. Woodward's[3] account of the ore found at Guarnek, in the parish of St. Allen, near Truro :—" It was a blue lead ore, very rich in silver, perhaps beyond any in England besides; this ore, when only dressed, sells for £8 a ton, which is about the value

[1] Carne, J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, p. 120.

[2] " The Geology of Camborne and Redruth " (*Mem. Geol. Surv.*), 1906, p. 230.

[3] " Mineralogy," Vol. II, p. 29.

of the lead itself . . . a ton of this lead yields 140 ozs. of silver; the vein of ore was about a foot over, but in some parts near 3 ft. and about 15 fthms. deep."[1]

Carne (*loc. cit.*) states that " in 1814 it was again set at work, and continued about two years. During this period it produced eight hundred tons of silver lead ore, containing thirteen parts in twenty of lead, and the lead yielding seventy ozs. of silver per ton."

Great Wheal Baddern or Baddon, Kea.

(*Idle.*)

Shafts situated about half-a-mile north of Bissoe and 2 miles by road from Perranarworthal Station (Truro and Falmouth Branch, G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 352; 6-in. Cornwall, 64 N.W. H.O. Plan No. R 215.

Memoir.—" The Geology of Camborne and Redruth," p. 292.

The country-rock consists of dark-grey slates of the Mylor Series. The lead lode courses north-north-east and underlies east-south-east. Its outcrop has been traced for upwards of half-a-mile.

The mine was working in 1850; in 1870 it was 70 fthms. deep, adit-level being at 10 fthms.

Since 1848 the recorded output of lead-ore amounted to 3,160 tons containing 2,230 tons of lead and 37,611 ozs. of silver. Two hundred and two tons of zinc-ore and some arsenical pyrites were also raised.

Sundry Minor Occurrences.

The following mines have yielded small quantities of lead-ore, sometimes containing silver, but beyond returns of output, very little information about them is extant.

Callestock Mine, 300 tons; Chiverton Valley, 85 tons; Wheal Constance, 110 tons, and 2,700 ozs. of silver; Cubert United Silver Lead Mine, 640 tons, and 6,550 ozs. of silver; Cubert, 500 tons; East Chiverton, 350 tons, and 4,080 ozs. of silver; Newquay Mine, 75 tons; North Wheal Rose, 1,350 tons, and 12,610 ozs. of silver; Oxnams Land, 1,200 tons, and 465 ozs. of silver; Pencorse Consols, 15 tons, and 2,950 ozs. of silver; Wheal Rose, 1,250 tons; and South Cargoll, 430 tons and 3,350 ozs. of silver. There are some other mines with outputs of lead-ore under one hundred tons.

The first discovery in Cornwall of both silver-ore and native silver was made about 1788 at Wheal Mexico in Perranzabuloe. The ore occurred in a north and south lode, and some fibrous native silver was found in the gossan.[2]

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[1] Borlase, W. "The Natural History of Cornwall," Oxford, 1758, p. 210.

[2] Carne, J. *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 118-26.

III.—The Liskeard District.

The Liskeard District covers an area of about 30 sq. miles consisting of Middle and Upper Devonian slates, volcanic rocks and intrusive sills and dykes. Within this area there are three nearly parallel zones where lodes bearing lead-ores occur. The lodes course nearly north and south, underlie both west and east, and are broken up by cross-courses or "slides." None of the lead lodes occurs in rocks metamorphosed by the granite, but the northern end of the Ludcott Lode approaches close to such rocks.

The district has been described by many observers, among whom the following deal with the lead mines :—Giles,[1] Henwood,[2] Salmon,[3] Foster,[4] Webb and Geach,[5] and J. H. Collins.[6]

The first group of lodes is situated near Herodsfoot, about $3\frac{1}{2}$ miles south-west of Liskeard; the second at Trelawny, $2\frac{1}{2}$ miles east, and the third at Wheals Ludcott and Wrey, about 3 miles east-north-east of that town.

The Herodsfoot Lodes extend from south to north for a distance of three-quarters of a mile and were worked at the Herodsfoot, the North Herodsfoot, and the South Herodsfoot Mines.

The Trelawny Lodes were worked at Wheals Mary Ann, Trelawny, Trehane, Trewetha, and some other mines.

The Ludcott Lodes course parallel to one another, and in a general direction of north-north-east. They were worked at North Trelawny, Ludcott, Wrey and Penhawger Mines. Each of the three series possesses characteristics differing from the others. In the Herodsfoot Lodes the gangue consisted of quartz, of crystalline and chalcedonic character, frequently intergrown with chalybite, barytes, and some blende and iron pyrites; but did not contain fluorspar. In this gangue the lead-ore was galena, which occurred in isolated pieces of various sizes ("bunches"), but did not form a continuous vein. It was rich in silver, especially near some "slides" or cross-courses. The lode had a good gossan, where beautiful crystalline masses of cerussite and lead phosphate were found. It had an underlie to the west and a maximum width of about 3 ft.; but it varied greatly in width at different parts of its course, and also in depth. The Trelawny Lodes are larger than the Herodsfoot Lodes, and

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[1] Giles, John, "On the Metalliferous associations of the Liskeard Rocks," *Trans. Roy. Geol. Soc. Cornwall*, Vol. VII, 1865, pp. 198–207.

[2] Henwood, W. J. "On the Mines of Menheniot, Lanreath and Saint Pinnock," *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, pp. 699–722.

[3] Salmon, *Mining and Smelting Magazine*, Vol. II, p. 213.

[4] Foster, C. Le Neve, "The Lode at Wheal Mary Ann, Menheniot," *Trans. Roy. Geol. Soc. Cornwall*, Vol. IX, 1878, p. 152.

[5] Webb and Geach, "The History and Progress of Mining in the Caradon and Liskeard District," London, 2nd edition, 1863.

[6] Collins, J. H., "Notes on the Principal Lead-bearing Lodes of the West of England," *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 683–718. "Observations on the West of England Mining Region," *Trans. Roy. Geol. Soc. Cornwall*, Vol. XIV, 1912.

vary in width from 2 ft. to 5 ft. They underlie to the east, but in places are vertical. Their characteristic gangue mineral is whitish-brown fluorspar, and in this respect they differ conspicuously from the Herodsfoot Lodes. The commonest form of the fluorspar was the cube, some specimens measuring 4 ins. across; others are octahedral. Barytes was common down to the 40-fthm. level; but below that was seldom seen.[1] The crystals generally formed a growth on the fluorspar, especially at Wheal Mary Ann.[2] Quartz composed the bulk of the gangue and occurred in many forms. Some of the waste material on the dumps consists of smoky-blue chalcedonic quartz, often stalactitic. Many specimens of galena are studded with brilliant little doubly terminated pyramids of quartz. The lodes carried rich gossans containing crystalline and massive carbonate of lead. Beneath the gossans considerable quantities of phosphate of lead occurred. At Wheal Trelawny the downward distribution of the minerals was well marked. In the gossan there were masses of the carbonate and of the phosphate of lead; immediately below the gossan, quartz and fluor composed the gangue in which the galena occurred in bunches, and at still greater depths there were large quantities of iron-pyrites and smaller proportions of blende with galena. Some sulphide of copper occurred in different parts of the lode, and became so intermixed with the galena at depth that the value of the ore greatly deteriorated.[3] It was, however, observed that where copper sulphide accompanied galena unusually large amounts of silver were found. It was further remarked that whether the ore were massive or in separate crystals, quartz and fluor were the only matrices in which it occurred and also that the most perpendicular parts of the lodes were always the most productive.[4] Foster[5] described the part of the lode at Wheal Mary Ann which was being worked just before the mine closed down. It was at one end of the 250-fthm. level and from the sections he deduced the following history of the lode:—(1) the formation of a fissure, probably accompanied by a shifting of the strata when a succession of open spaces were left, and some parts more or less filled up by fragments that fell from the walls; (2) the deposition of the "cab" which cemented the fragments of the walls into a breccia, and finally (3) the re-opening of the fissure and the successive deposition of quartz, galena, chalybite and calc-spar. There were two periods of formation of fluorspar; the lead-ore was deposited at an intermediate period, and the last minerals deposited were quartz, chalybite, and calc-spar.

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[1] Giles, *Op. cit.*, p. 204.

[2] Henwood, W. J., *Rept. Roy. Inst. Cornwall*, Vol. XXXIII. 1851, pp. 40-43.

[3] Giles, *Op. cit.*, p. 205.

[4] Henwood, W. J., *Rept. Roy. Inst. Cornwall*, Vol. XXXIII, 1851, pp. 40-43.

[5] Foster, C. Le Neve, *Op. cit.*, p. 152.

In the lodes of the Ludcott and Wrey Mines the shallow parts consisted of granular quartz, slaty clay, and earthy brown iron-ore, slightly and irregularly sprinkled with iron pyrites, copper pyrites, blende, and galena; but, deeper down, the quartz assumed some characters of hornstone, calcareous matter appeared, and, at intervals, the lodes were rich in galena.[1]

The lode was notable on account of the occurrence of very large and perfect crystals of barytes and fluorspar and also of rich argentiferous minerals.[2] The galena was frequently rich in silver, which was of unequal distribution in the different lodes and in different parts of the same lode. It was richest, however, in the cross-courses which trended east and west. In Wheal Trelawny, at a depth of 105 fthms. the lead afforded ·0012 its weight of silver; at 210 fthms., ·0014; at Wheal Mary Ann, at a depth of 98 fthms., ·00134; at 256 fthms., ·00132. In both mines, however, the least argentiferous of the ore wrought at the greatest depths gave larger proportions of silver than that found nearer the surface. At Herodsfoot the lead-ore afforded the following proportions of silver: at a depth of 141 fthms., ·00035; at 160 fthms., ·00065.[3] At Wheal Ludcott at depths ranging from 93 to 110 fthms. the northern cross-course yielded single crystals of galena, but slightly argentiferous, imbedded in large bunches of vitreous silver-ore, crystalline granules, sometimes of ruby silver-ore (pyrargyrite) . . . "and earthy black silver-ore investing as well crystals of galena, as flakes and threads of native silver."[4]

Herodsfoot and North Herodsfoot, Duloe and Lanreath.

(*Idle.*)

Shafts situated near Herodsfoot, on the western bank of the Looe River, and about 3½ miles south-west of Liskeard.

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 43 N.E. H.O. Plan No. R 146; North Herodsfoot, Plan No. 1830, deposited at H.O. in 1886.

Memoir.—"The Geology of Plymouth and Liskeard," pp. 134–138.

The country-rock consists of the grey, silty slates of the Middle Devonian. The lode courses nearly due north and south and underlies west[5] at 70°. Giles, however, states that it underlies east.[6]

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[1] Salmon, *Mining and Smelting Magazine*, Vol. II, pp. 78–83.

[2] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 693.

[3] Henwood, W. J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, pp. 709, 710.

[4] Henwood, *op. cit.*, p. 710.

[5] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 694, 695.

[6] *Ibid.*, Vol. VII, 1865, p. 202.

According to Collins[1] it varies up to 4 ft. in width although Webb and Geach[2] give its maximum width as 3 ft. It is intersected by two belts of slidy ground, the first at a distance of 150 fthms. north of the engine-shaft, and the second south of that shaft. This ground was described by Giles[3] as trappean slate having the appearance of elvan, but distinguished by an imperfect structure. It threw the larger portion of the lode a few degrees east of its bearing and the remainder 40° westward. Salmon[4] states that the slidy ground extended for a considerable width, obliterating the lode, although detached pieces of ore occurred in it. It narrowed from 60 fthms. at the surface to 30 fthms. at a depth of 150 fthms., and continued to decrease at depth. Mining operations almost ceased when this ground was first encountered, but the levels on being driven through it entered rich ore on its southern side, and a new shaft was sunk. According to Collins[5] " the ore-ground was not very rich, but there was a great deal of it, and it was followed down to a depth of about 150 fthms., some of the levels being extended for a distance of 140 fthms. to the north of the shaft, while southward they were driven up to a belt of slidy ground for an equal distance, where the lode was found to be broken up and valueless . . . . to the south of this belt . . . the ore was found to be much richer in silver than it had been to the north." The lode south of the slidy ground yielded nine or ten cwts., but occasionally two to three tons of lead-ore to the fathom. The gangue consists of quartz, sometimes crystalline, often hyaline, or of pale blue chalcedony. Siderite is associated and in part intergrown with it. There is a fair amount of iron pyrites, blende, barytes, and some copper pyrites, but fluorspar has not been observed. Some beautiful specimens of tetrahedrite (antimonial sulphide of copper) were found in the upper workings, but as Giles[6] remarks, the antimony-bearing minerals occurred just below the gossan and died out in the lower levels. He also records the presence of " bunches of rich sulphuret of copper in the parts of the lode richest in galena." Of the succession downwards of the various minerals Henwood[7] observed that amongst the abundant earthy brown iron-ore and granulated quartz there were small masses of the carbonate and of the phosphate of lead in the shallower parts of the lode, while galena increased in quantity at greater depths. In the most productive part the quartzose gangue contained single granules, isolated blocks, and small masses of ore connected by thin veins.

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[1] *Op. cit.*, p. 695.

[2] " History of Mining in the Caradon and Liskeard District," 2nd edit., 1863, p. 17.

[3] *Op. cit.*, p. 203.

[4] *Mining and Smelting Magazine*, Vol. II, p. 213.

[5] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 695.

[6] *Op cit.*, p. 202.

[7] *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 707.

According to Salmon[1] the most highly argentiferous galena is that of a very fine grain, the coarsely crystalline ore being poor in silver. Specimens of the lode material lying on the dumps show a zonal arrangement of minerals in which galena lies nearest the walls. The lead-ore extracted from different parts of the lode has afforded the following proportions of silver: from the Old or Northern Mine at a depth of 141 fthms., ·00035; from the New Mine at a depth of 160 fthms., ·000653 to ·001895. Between the proportions of lead and silver, however, there seems no necessary connection.[2] According to the Home Office plan the ore bodies were chiefly between the 60- and 84- and the 106- and 137-fthm. levels near the engine-shaft, and from the 70- to the 127-fthm. at the Windsor Shaft.

The recorded output from 1848 to 1884 was 19,010 tons of lead-ore, containing 13,470 tons of lead, and 616,590 ozs. of silver. The silver was produced between 1853 and 1884. There were also 5 tons of wolfram and 17 tons of copper-ore.

Wheal Trelawny (afterwards Hony and Trelawny), Menheniot.

(Idle.)

Shafts situated beside the main road two-thirds of a mile north of Menheniot Church, and one and a half miles by road from Menheniot Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 36 S.E.

Memoir.—"The Geology of Plymouth and Liskeard," pp. 135, 137, 138.

The country-rock consists of dark-grey shaly slate, with rippled surface, of Upper Devonian age. There is much volcanic rock interbedded with the slates in the neighbourhood.

The course of the lode varies from 8° east to 5° west of north; the underlie is to the east at from 60° to 80°, and the width ranges from 2 to 6 ft. The lode contained the largest amount of ore where it was most nearly vertical.

Mining operations were started in 1844 and continued until 1871. The lode proved productive throughout the sett for a length of 500 fthms., but the depth to which it was mined is unknown. In 1862 there were five levels working at 10 fthm. intervals from the 142- to the 182-fthm. levels[3] and five shafts—Smith's, Chippendale's, Trelawny's, Vivian's, and Phillips. In 1869 the mine was 210 fthms. deep.[4] On the Home Office plan it is shown as 220 fthms. deep. The lode is intersected by a flucan which bears 10° S. of E., dips S. 50°–60°, and varies from 6 to 18 ins. in width. It consists of clay identical

[1] *Mining and Smelting Magazine*, Vol. II.
[2] Henwood, *op. cit.*, pp. 709, 710.
[3] Webb and Geach, *op. cit.*, pp. 90, 91.
[4] Henwood, *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 709.

in composition with the adjacent rocks and heaves the lode different distances, varying from 2 to 12 ft., at different levels. The deeper part of the lode is intersected by at least one cross-vein which was not recognised near the surface.[1] In the 55-fthm. level, Henwood saw a remarkable spherical concretion, measuring a foot across, which had a nucleus and an external envelope of galena separated by four different layers of quartz; it was embedded in quartz-cemented slaty matter. There are extensive dumps consisting largely of fluorspar and barytes with some galena. The debris is often cemented together by a matrix of secondary lead carbonate. From 1900 to 1902 these dumps were partly worked over for arsenical ores and some silver-lead- and zinc-ores were also obtained. In 1919 fluorspar and barytes were being recovered, and it was intended shortly to unwater the mine.

From 1848 to 1871 the output amounted to 23,180 tons of lead-ores containing 16,726 tons of lead and 680,740 ozs. of silver. The silver was produced between 1853 and 1871. There were also 920 tons of iron pyrites, 7,230 tons of arsenical pyrites, and and 460 tons of crude and refined arsenic. Hony and Trelawny produced 88 tons of lead-ore containing 60 tons of lead in 1883 and 1884.

Wheal Mary Ann, Menheniot.

(Idle.)

Shafts situated to the west of the road and about half a mile north of Menheniot Church.

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 36 S.E. H.O. Plan No. R 8 and No. 177, deposited at H.O. in 1875.

Memoir.—" The Geology of Plymouth and Liskeard," pp. 135, 137, 138.

The country-rock consists of soft, grey slate and interbedded volcanic rock of Upper Devonian age.

The lode courses nearly due north, but varies locally from 8° east to 5° west of north; it underlies east at 79°, and ranges up to 4 ft. in width.[2]

The mine started in 1846 and by 1862 had been thoroughly worked down to the 160-fthm. level. According to Webb and Geach[3] the lode was productive to the surface at Barnett's Shaft, but deteriorated rapidly in a southerly direction. At Pollard's Shaft it was barren down to the 10-fthm. level; at Clymo's Shaft it was of low grade down to the 40-fthm.; southwards from this point it dipped to a large channel of broken ground of the nature of a slide or cross-course. They also state that nearly the whole

[1] Henwood, W. J., *Rept. Roy. Inst. Cornwall*, Vol. XXXIII, p. 43.

[2] Henwood, W. J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 704.

[3] " History of Mining in the Caradon and Liskeard District," 1862, pp. 26, 92.

of the lode was worked out from the surface to a depth of 150 fthms., and that the lode became poor and ultimately barren as the cross-course was approached. This broken ground was driven through, but without success. In 1874, work was continuing only at the 250-fthm. level, although the mine had been worked in 1870 to below the 300-fthm. level.[1] Salmon states that " the lode south from Pollard's shaft at the 172-fthm. level consisted of $1\frac{1}{2}$ ft. wide of capels and 1 ft. of fluorspar with a little carbonate of lime. . . . North of Pollard's the lode is 4 ft. wide, composed of carbonate of lime and fluorspar worth 6 cwt. of ore per fathom, with 2 ft. of capels on the west side."[2] Towards the south of the mine the lode is represented by mere bunches and short narrow strings of slightly metalliferous vein-stone. These mostly follow such joints as maintain the normal directions of the lodes; but they rarely affect parallel portions of proximate joints. There is a flucan which bears 22° to 28° S. of E., dips N.E. at 40° to 50°, and ranges up to a foot in thickness. In some places this merely divides the lode without displacing it, in others, heaves it about 2 ft.[3] Giles[4] states that in the southern part of the mine an elvan of dyke-like character occurs, " and yet for the first 70 fathoms it consists merely of three branches. But between the 70 and 80 fathoms levels these branches altogether disappear and are succeeded still further south by a regular elvan course . . ." He further states that where the lode occurred in elvan it produced galena even in the hardest parts in much greater abundance than it did while traversing the killas. In the hard killas the lode was smaller, but contained from 13 to 17 ozs. per ton more silver than in any other part of the mine.[5]

Some crystals of fluorspar, found in this mine, are of exceptionally large size; one specimen, now preserved in the Museum of Practical Geology, consists of cubes measuring more than a foot along the edge and built up of an aggregation of smaller cubes.[6]

The recorded output between the years 1848 and 1875 is 29,600 tons of lead-ore which contained 20,132 tons of lead. The amount of silver produced from lead between 1854 and 1875 amounted to 1,126,130 ozs. Collins[7] states that " the ores produced realised close upon one million sterling." On the plans at the Home Office it is stated that at Clymo's shaft " all the ground above 210 fthms. has been worked away and the levels gone together," while the same remark is applied to all

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[1] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 692.

[2] *Mining and Smelting Magazine*, Vol. II, pp. 215–21.

[3] Henwood, W. J., *Rept. Roy. Inst. Cornwall*, Vol. XXXIII, p. 43.

[4] *Trans. Roy. Geol. Soc. Cornwall*, Vol. VII, 1865, p. 206.

[5] Giles, *Op. cit.*

[6] Rudler, F. W., " Handbook to the Minerals of the British Islands," 1905, p. 86.

[7] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 692–3.

ground throughout the mine down to the 110-fthm. level. Levels are shown down to the 250-fthm. at 10-fthm. intervals.

Wheal Trehane, Menheniot.

(*Dumps working.*)

Shafts situated about half a mile north of Menheniot Church.

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 36 S.E.

Memoir.—" The Geology of Plymouth and Liskeard," pp. 135, 137, 138.

The country-rock is Upper Devonian slate, soft and dark grey in colour. The lode is the same as that worked in Wheal Mary Ann and Wheal Trelawny. Work commenced in 1843 and ceased in 1857. The output of lead-ore between 1848 and 1858 amounted to 4,220 tons containing 2,767 tons of lead. There were also 57,650 ozs. of silver from lead produced between 1853 and 1858.

Wheal Treweatha, Menheniot.

(*Idle.*)

The shafts are situated immediately to the south of Treweatha farm-place and rather more than 2 miles by road north of Menheniot Station (G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 36 N.E.

Memoir.—" The Geology of Plymouth and Liskeard," pp. 135, 137, 138.

The country-rock consists of Upper Devonian slates interbedded at the southern end of the mine with volcanic rocks. An elvan was proved underground in the northern workings.

The lode courses a little east of north and underlies east. It increased in width downwards from 4 ins. to a foot and averaged about 10 ins. A caunter lode forms a junction with the main lode at 50 fthms. south of the new engine shaft. Between the 13- and the 70-fthm. levels the lode was rich, but beneath the 70-fthm., although it increased in width, it deteriorated in value, and at the 100-fthm. level became too poor to be worked.

Levels were driven southwards from the Old Engine Shaft for 420 ft., but were stopped, it is said, because a lease could not be obtained of adjacent land thought to be valuable.[1] There were four shafts.

The output between 1853 and 1872 amounted to 4,236 tons of lead-ore containing 2,955 tons of lead and 145,366 ozs. of silver. The proportion of silver in the lead-ore and the lead were ·00123 and ·00202 respectively.[2]

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[1] Webb and Geach, " History of Mining in the Caradon and Liskeard District," 1863, p. 63.

[2] " Mineral Statistics " (*Mem. Geol. Surv.*), 1857, pp. 31, 32.

Wheal Wrey and Wheal Ludcott, St. Ive.

(*Idle.*)

Maps.—One-in. New Series Ordnance and Geological, 348; 6-in. Cornwall, 36 N.E. Wrey Consols, H.O. Plan No. R 216.

The shafts at Wheal Ludcott are situated a little over a sixth of a mile east-south-east of Butterdon Mill, and about 4 miles by road north of Menheniot Station (G.W.R.).

Wheal Wrey lies about a third of a mile north of Wheal Ludcott. The mines were at first worked separately, but in 1863 they were amalgamated and worked as Ludcott and Wheal Wrey Mines.

The country-rock consists mostly of soft blue killas of Upper Devonian age. The lodes form a group which courses roughly parallel with the great lode worked at Wheals Mary Ann and Trelawny, but at a distance of 2,000 ft. further to the east.

The following account is abstracted from Salmon,[1] and from Webb and Geach.[2]

There are two lodes about 70 fthms. apart which course a few degrees east of north and are nearly parallel. They average from 2 to 3 ft. in width and dip from 80° to 86° east. They have been wrought, one to about 80 fthms. and the other to more than 130 fthms. in depth. There is a third lode to the east, of which scarcely anything is known. The shallower parts of both lodes consisted of granular quartz, slaty clay and earthy brown iron-ore, slightly and irregularly sprinkled with iron pyrites, copper pyrites, blende and galena; but beneath, the quartz assumed some characters of hornstone (chalcedonic quartz), calcareous matter appeared, and at intervals, the lodes were rich in galena, which yielded from 0·000746 to 0·00120 per cent. of its weight of silver. There are also three cross-veins, which course about east and west, dip south at 60° to 70°, and measure usually from 1 ft. to 3 ft. in width. In one case, however, the width was 18 ft. All three intersect both the lodes, but whilst the southern-most and the middle cross-vein heave both towards the east, the northern one heaves them in the opposite direction. The cross-courses consist of slaty clay mixed with quartz, calc-spar, carbonate of iron and iron pyrites; masses of chalcedonic quartz, small quantities of copper pyrites and some galena also occur. The northern cross-course afforded argentiferous galena, vitreous silver-ore, pyrargyrite and native silver. According to Webb and Geach[3] a considerable quantity of "ruby silver" was raised. The fluorspar is nearly all purple at Wheal Wrey whereas at Wheal Ludcott it is green, pink, or colourless, and purple is rarely seen. Collins[4] says that "very large and perfect crystals

[1] Salmon, H. C., *The Mining and Smelting Magazine*, Vol. II, pp. 78–83.

[2] "History of Mining in the Caradon and Liskeard District," 1863, pp. 18–24.

[3] *Op. cit.*, p. 23.

[4] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 693, 694.

of barytes and fluor" were found at Wheal Wrey and "in some parts of Wheal Ludcott . . . remarkable deposits of rich silver minerals, native silver, argentite, pyrargyrite, proustite, stephanite, &c., in very considerable quantities. . . . The lode itself was rarely very rich, but the silver-bearing portion of the 'cross-course' was in places 2 to 3 ft. wide, largely interspersed with argentite, and worth probably at points, more than 1,000*l.* per fathom."

The total recorded output from these mines is as follows:—Wheal Ludcott, 3,200 tons of lead-ore, containing 2,180 tons of lead and 105,810 ozs. of silver; 12 tons of silver-ore and 69 tons of rich silver-lead. This was between the years 1856 and 1862.

Ludcott and Wrey had an output from 1863 to 1866 of 1,870 tons of lead-ore, yielding 1,255 tons of lead and 81,580 ozs. of silver; also 87 tons of rich silver-lead.

Wheal Wrey Consols between 1853 and 1862 yielded 5,435 tons of lead-ore, containing 3,744 tons of lead and 107,020 ozs. of silver.

From 1861 to 1864 Wheal Ludcott sold 306 tons of silver-ore. This was mostly obtained in a vein which crossed the principal lode and from near the point of intersection.

IV.—The Saint Kew District.

This district includes the area north of the River Camel and west of Bodmin Moor. The country-rock consists of slates, sometimes slightly calcareous, with local thin beds of limestone, of Upper Devonian age. Associated with these sediments are pillow lavas in which argentiferous galena and antimony-ores frequently occur. There are also numerous sills of diabase and minverite, but lead-ore has not been seen in them.

The upper levels of many of the mines show recent growths of cerussite and pyromorphite, and beautiful specimens of these minerals and of jamesonite and bournonite have been obtained.

Trevinnick, Treburgett and Pengenna Mines were all active in 1919. In addition to the mines described in the following pages there are many small workings about which very little is known; their output is small amounting to less than a 100 tons of lead-ore.

Pentire Glaze, St. Minver.

(*Standing.*)

Shafts situated about half a mile east-north-east of Polzeath and 7 miles by road from Wadebridge Junction (L. and S.W. and G.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 336; 6-in. Cornwall, 18 N.E.

Memoir.—"The Geology of Padstow and Camelford," pp. 102, 105, 106.

The country-rock consists of Upper Devonian grey and variegated slates and an intrusion of greenstone.

The lode courses east and west. A north and south silver-lead lode has also been worked.[1] The north and south lode underlies east. According to Rudler[2] "many of the finest examples of cerussite are from this mine. . . they still retain sufficient of the gossan matrix to attest the superficial origin of the mineral. The cerussite occurs chiefly in long slender crystals, often acicular and sometimes of great delicacy, and these by their snow-white colour contrast strikingly with the dark-brown limonite on which they are displayed."[3]

The gangue as seen on the dumps consists mainly of brecciated slate cemented with quartz. In this some galena may still be observed, but cerussite is rare. There is a little peacock copper-ore and chalcopyrite.

The recorded output between 1850 and 1857 was 955 tons of lead-ore containing 632 tons of lead. Between 1853 and 1857 the output of silver from lead-ore amounted to 19,065 ozs.

Treburgett, St. Teath.

(*Active.*)

The entrance to the adit level is situated about half a mile south-west of St. Teath Church, and one and a quarter miles by road from Port Isaac Road Station (L. and S.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 336; 6-in. Cornwall, 20 N.W. H.O. Plans, Treburgett, No. 855 and Old Treburgett, No. R 44.

Memoir.—"The Geology of Padstow and Camelford," pp. 102, 105, 106.

The country-rock consists of grey slate of Upper Devonian age.

There are two principal lodes known as the Main Lode, and the East and West Lode or the Cross Course. The Main Lode courses N. 25° E. and underlies north-west at 62° from the horizontal. It averages about 4 ft. in width. The gangue consists of brecciated country-rock cemented with quartz and calcite. The following section of this mine (Fig. 4) was published,[4] by mistake, as that of the Pawton Mine.

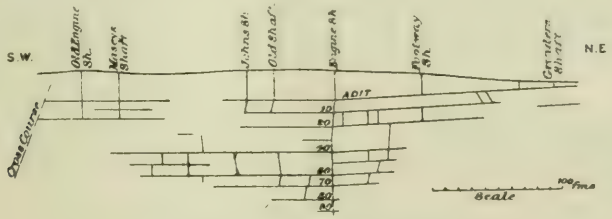

Fig. 4.—*Treburgett Mine.*

[1] "The Geology of Padstow" (*Mem. Geol. Surv.*), 1910, p. 102.

[2] "Handbook to the Minerals of the British Islands" (*Mem. Geol. Surv.*), 1905, p. 56.

[3] *Op. cit.*, p. 55.

[4] "The Geology of Padstow and Camelford" (*Mem. Geol. Surv.*), 1910, p. 101, Fig. 6.

The mouth of the adit level is beside the stream near Whitewell. There are seven shafts on the main lode known respectively from south-west to north-east as the Old Engine Shaft, Maseys Shaft, John's Shaft, Old Shaft, Engine Shaft, and Footway Shaft. Grindler's Shaft is on the east and west lode.

The Engine Shaft is 102 fthms. on the incline. Adit level at that shaft is 22 fthms. below the surface. There are levels at 10 fthm. intervals down to the 90-fthm. level below adit. Most stoping appears to have been done on the 10-, 20-, 40-, 60- and 70-fthm. levels, while the richest ore, according to local reports, was found at the 40-, the 60-, and the 70-fthm. levels.

The lode had a rich gossan in which secondary minerals derived from galena occurred in association with some others containing antimony. The following particulars are abstracted from a report published in the Mining Journal[1] :—In June 1920, the water had been lowered to below the first level where a fine lode of zinc-ore 3 ft. thick has been found, some thousands of tons being in sight. The ore is being mined. In the old stopes at this level there is a large amount of rubble which on being crushed and jigged yields a ton of lead-ore to 5½ tons of rubbish, and assays from 40 to 55 ozs. of silver to the ton of lead. To the west of the property some good ore has been found, giving three of rock to one of galena, which is rich in silver.

Collins states that " Old Treburgett was remarkable for its occasional ore-shoots of rich antimonial silver, though the lead ore itself was usually poor in silver."[2]

There is an area of maiden ground between the southern boundary of Treburgett and the northern boundary of Trewethen, the back of the lode being traceable along the hill-crest. It is thought to be productive ground.

The output between 1871 and 1881 amounted to 2,180 tons of lead-ore containing 1,640 tons of lead and 9,550 ozs. of silver. There were also 44 tons of zinc-ore.

Pengenna Mine, St. Teath.

(Standing.)

Adit and shafts between Trewethen and Pengenna and about one and a half miles south-west of St. Teath Church and one and an eighth miles by road from Port Isaac Road Station (L. & S.W.R.).

Maps.—One in. New Series Ordnance and Geological, 336; 6-in. Cornwall, 20 N.W.

Memoir.—" The Geology of Padstow and Camelford," pp. 102, 105, 106.

The country-rock consists principally of Upper Devonian black slate and in one part of the mine of volcanic rock.

There are two lodes, the Trewethen Lode and the Pengenna or Caunter Lode. The Trewethen Lode courses nearly north-east

[1] Vol. CXXIX, No. 4425, June 12th 1920, p. 458. An account of the mine was published in the *Mining Journal*, 29th October, 1870.

[2] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, pp. 697, 698.

and underlies north-west at 45°. Its average width is 4½ ft. the gangue consists of brecciated country-rock cemented with quartz and calcite.

The Pengenna Lode courses nearly north, underlies west and averages about 6 ft. in thickness. The gossan is rich in silver; the assays are said to show up to 93 ozs. per ton of lead. The top 40 fthms. are rich in antimony minerals but below that level galena replaces the antimony-ores. At a distance of 22 fthms. east of the Pengenna Lode there is said to be another lode which contains antimony-ore. It courses north-west, underlies south-west, and is about 4½ ft. wide.

There are three shafts on the Trewethen Lode. The adit level lies at a depth of 30-fthms. below the surface at the middle shaft, and the lode has been stoped down to it.

The mouth of the adit is near Watergate, and at a distance of 15 fthms. the level strikes the lode. The shaft on the Pengenna Lode meets a level at 40 ft. from the surface; the adit is 10 fthms. deeper.

Trevinnick Mine, St. Kew.

(Active.)

The shafts are situated at Lower Trevinnick, one and two-third miles south-south-east of Port Isaac and about 3 miles by road from Port Isaac Road Station (L. & S.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 336; 6-in. Cornwall, 19 N.E.

Memoir.—" The Geology of Padstow and Camelford," pp. 104, 106.

The country-rock is principally lava; near the shafts there is also some killas.

There are three lodes, one containing galena; the second, antimony- and silver-lead-ores; while the third is a caunter lode. The silver-lead lode courses nearly north and south, underlies west at 40°, and varies in width from 2 to 6 ft. The gangue is principally quartz. There is a good gossan in which many secondary minerals occur, including some beautiful growths of cerussite and pyromorphite. In the lead lode galena occurs in masses up to 3 ft. in thickness. The antimony-ore is chiefly in the form of large lenticles of jamesonite, some measuring 2 ft. in length. Antimony-ochre and antimonial-silver also occur, and rarely auriferous copper-ore.

The gossan contains masses of lead carbonate associated with lead chlorophosphate; it passes downwards into a zone of galena. Some blende and chalybite are also found near the surface. Recent assays by Johnson's, supplied by the Company, show the following results: antimony, 33 per cent.; lead, 37 per cent.; sulphur, 17 per cent.; silver, 6 ozs.; and gold, ·1 oz. to the ton. Other assays indicate the proportion of silver as varying from 22 to 65 ozs. per ton of lead.

The deep adit lies 250 ft. below the working adit.

Lead-ore occurs in small quantities in association with silver- and antimony-ores at many small mines in this district.

CHAPTER III.

EAST CORNWALL AND DEVON.

V.—The Tavistock District.

In this district is included the area between Bodmin Moor and Dartmoor where the mines lie either around the small granite masses of Kit Hill and Hingston Down or near the borders of Dartmoor. The Tamar lead mines are among the oldest in the West of England; their lead-ore was rich in silver. The Holmbush Mine lead-lode is a north and south cross-course which lies inside the belt of metamorphosed rocks around the Kit Hill granite. The lode at Wheal Betsy, north of Tavistock, is also a cross-course and is close to the metamorphic rocks surrounding the Dartmoor granite. The old mine at Ivybridge lies to the east of Plymouth and south of the Dartmoor granite.

Some of the richest silver-ores of the West of England were found near Calstock at Wheal Vincent, Wheal Duchy and Wheal Langford.

The Tamar Lead Mines, Beer Alston, and Beer Ferrers.

(*Idle.*)

The mines extend in two parallel lines from Calstock southwards for a distance of nearly 3 miles.

Maps.—One-in. New Series Ordnance and Geological, 337 and 348; 6-in. Devon, 111 N.W. and S.W.

The country-rock consists of Upper Devonian slates overlain by Carboniferous shales. There are two parallel lodes about three quarters of a mile apart and coursing nearly due north. On the western lode are the following mines, commencing at the north: Ward, South Ward, H.O. Plans Nos. 689 and R 143; North Hooe or Hancock or North Tamar, H.O. Plan No. R 264; and South Hooe, H.O. Plan No. R 264. From north to south on the eastern lode are the Tamar Valley, H.O. Plan No. R 274; Lockeridge; Furze Hill and the South Tamar Mine, H.O. Plan No. R 7.

Northwards from Calstock the eastern vein has been traced as a sparry cross-course but contains only traces of galena[1]. The lodes "were very comby and vughy, and contained chalybite and blende, with much fluor spar, which often occurred in very beautiful and highly modified crystals."[2] In or near the granite the lodes were mostly non-metalliferous. The galena was rich in silver and according to Henwood and Rees[3] samples from

[1] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 688

[2] Collins, J. H., "The West of England Mining Region," 1912, p. 267.

[3] *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 110.

the shallow parts of the Tamar mines contained about 145 ozs. and some from the deep levels from 35 to 40 ozs. of silver to the ton. De la Beche[1] states that the produce of the mines was unusually great in the reigns of Edward I. and Edward II. In 1293 William de Wymundham accounted at the Treasury for 270 lb. of silver raised in Devon. There are other records of the Middle Ages relating to these mines, which state that they were worked during the 13th century at the King's own cost. Their argentiferous character was then well understood. In 1784 and 1785 the silver produced amounted to 6,500 ozs.

The plans of the mines at the Home Office show the following particulars :—the Tamar Silver Lead or North Hooe Mine has been worked down to the 226-fthm. level, the principal stoping being to the north of the shaft at the 30-, 40-, and 50-fthm., all along the 60- and 70-fthm. levels, and in the middle part of the 90-fthm. There is a note that the western lode, or that worked at the North Hooe and the South Hooe Mines " abounds very much in silver-lead."

The Beer Old Mines, Nos. 1 to 6, lie in a north and south line along the course of the lode. Mr. Robert Hunt traced the plans from the originals in the possession of Mr. Williams of Scorrier, in September 1855. No. 3 Mine was then called the Cleave and Birch. There is a note that " the bottoms of these old works have never been seen since the reign of Queen Elizabeth." No. 4 Mine is the Furze Hill and Whitstone Down Mine. No. 5 is the Gold Street Mine. The lode thence courses north-east to No. 6 or the Butspill Mine, and there also the bottom of the mine has not been seen since the reign of Elizabeth.

There are two plans, dated respectively 1850 and 1858, of the Tamar Silver Lead Mine. The lode courses north and south and underlies east at 5 in 18. The plan of earlier date shows levels down to the 190-fthm. at the Engine Shaft and there are two slides indicated. The 1858 plan shows levels down to the 226-fthm., with the ore-body extending to the south, leaving large vacant spaces near the Engine Shaft on the north. The underlie of the lode changes at different parts of the course.

At the South Tamar Consols Mine the lode courses north-east and underlies south-east at 1 in 3. There are levels at 30, 45, 60, 70, 80, 90, 100, 112, 124, 136, and 148 fthms. and two shafts, Glynne's and the Engine Shaft.

The output of the Tamar Mines,[2] since the year 1848 was as follows :—

Tamar Mines (1848 to 1863).—13,291 tons of lead-ore and 600,000 ozs. of silver (computed).

Tamar Consols (1849 to 1860).—7,116 tons of lead-ore and 320,000 ozs. of silver (computed).

[1] " Report on the Geology of Cornwall, Devon and West Somerset," 1839, pp. 611, 612, 647, 648.

[2] Collins, J. H., *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 689.

East Tamar Consols, 1848 to 1861—2,338 tons of lead-ore and 46,000 ozs. of silver (computed).

The following outputs from these mines are taken from MacAlister[1]:—

——	Lead-ore.	Lead.	Silver.	Period of Working.
	Tons.	Tons.	Ozs.	
East Tamar Consols	2,580	1,782	19,530	Between 1845 and 1861.
South Tamar Consols	7,140	4,548	262,470	Lead between 1849 and 1860; silver between 1852 and 1860.
South Ward - -	130	73	390	Between 1873 and 1876.
Tamar Mine (Tamar Consols, and Tamar Silver Lead)	14,640	9,095	326,300	Between 1845 and 1876.
Tamar Mines - -	1,260	870	24,680	In 1860 and 1861.
Tamar Valley - -	95	70	650	Between 1870 and 1876.

Holmbush, Stoke Climsland.

(*Idle.*)

Holmbush is situated a few hundred yards north, and Redmoor, south of Kellybray Station (East Cornwall Railway), on opposite sides of the road from Callington to Stoke Climsland.

Maps.—One-in. New Series Ordnance and Geological, 337; 6-in. Cornwall, 29 N.W. East Holmbush, H.O. Plan No. R 317 and 86; Kelly Bray, No. R 178; Callington United Mines Nos. R 260, R 261, R 288, 4,000 and 4,001, deposited at H.O. in 1894.

Memoir.—"The Geology of Tavistock and Launceston," pp. 98, 99, 111, 112, 114, 115, 121, 124.

Holmbush, Redmoor and Kelly Bray were amalgamated as the Callington United Mines.

The country-rock consists of Upper Devonian sediment which is just within the limits of metamorphism effected by the Kit Hill granite.

The lead lode courses north and south and underlies west.

According to the longitudinal section (Fig. 5) the lode has

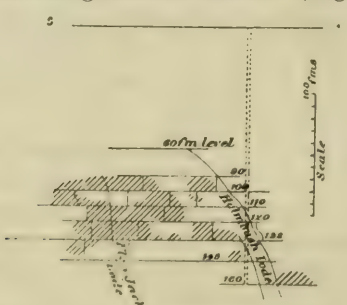

Fig. 5.—*Holmbush Mine. Longitudinal section of Lead Lode.*

[1] "The Geology of Tavistock and Launceston" (*Mem. Geol. Surv.*), 1911, pp. 116, 119, 120.

been largely stoped at the 90-, 100-, 110-, 120-, and 132-fthm. levels and to a lesser extent at the 145- and the 160-fthm. The lode intersects the tin-bearing Holmbush and Flop Jack Lodes nearly at right angles.

Collins states that when he reported on the mine in 1892, the lead lode had, except for a few pillars, been worked out down to a depth of 170 fthms. From the pillars "it was evident that there had been extensive shoots of ore from 3 to 6 ft. wide, and that the lode had been very comby, brecciated and pyritous."[1]

The output from 1846 to 1863 and from 1882 to 1886 amounted to 1,689 tons of lead-ore which contained 1,074 tons of lead; 20,093 ozs. of silver were got from the lead-ore raised between 1853 and 1863, and from that between 1882 and 1886. The adjacent Redmoor mine (formerly part of Holmbush) had an output of 272 tons of lead-ore, yielding 148 tons of lead and 9,170 ozs. of silver in various periods of work between 1858 and 1884. Eight tons of silver-ore were also got. Callington Mine produced 6,454 tons of lead-ore, 4,166 tons of lead between 1845 and 1854, and 6,713 ozs. of silver from 114 tons of lead-ore in 1853 and 1854.

Wheal Betsy, Marytavy.

(Idle.)

The mine is between Kingsett Down and Gibbet Hill, and nearly 2 miles by road north-north-east of Marytavy Station.

Maps.—One-in. New Series Ordnance and Geological, 338; 6-in. Devon, 98 N.W. H.O. Plans Nos. R 17 and 733, deposited at H.O. in 1877.

Memoir.—"The Geology of Dartmoor," pp. 76, 84.

The mine was first called Huel Betsy; it was re-named Prince Arthur, then North Wheal Friendship, and in 1869 the name Wheal Betsy was adopted.

The country-rock consists of slates and calc-flintas, of Carboniferous age.

The lode courses north-north-east and underlies a little north of west. According to Collins[2] the vein varies in width from 2 to 3 ft., and is mainly composed of quartz where it crosses the great copper lode of Wheal Friendship, but in Wheal Betsy it is much smaller, generally from 6 ins. to 3 ft., and here it is composed of quartz, slaty clay, earthy brown iron-ore, carbonate of iron and blende, with leaders and pockets of galena.

Wheal Betsy is an ancient mine which has been worked at several different periods. After a long period of idleness it was re-opened in 1806 and produced for some years an output of from 300 to 400 tons of lead and from 4,000 to 5,000 ozs. of silver; in 1835 it produced only 40 tons of ore.[3]

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[1] "The West of England Mining Region," 1912, p. 260.

[2] *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 687.

[3] De la Beche, H. T., "Report on the Geology of Cornwall, Devon and West Somerset," 1839, pp. 610, 612.

In 1843 the mine was 102 fthms. deep,[1] but before it closed down in 1877 the Main Lode had been worked on down to the 142-fthm. level below adit (Fig. 6). There were 12 shafts and

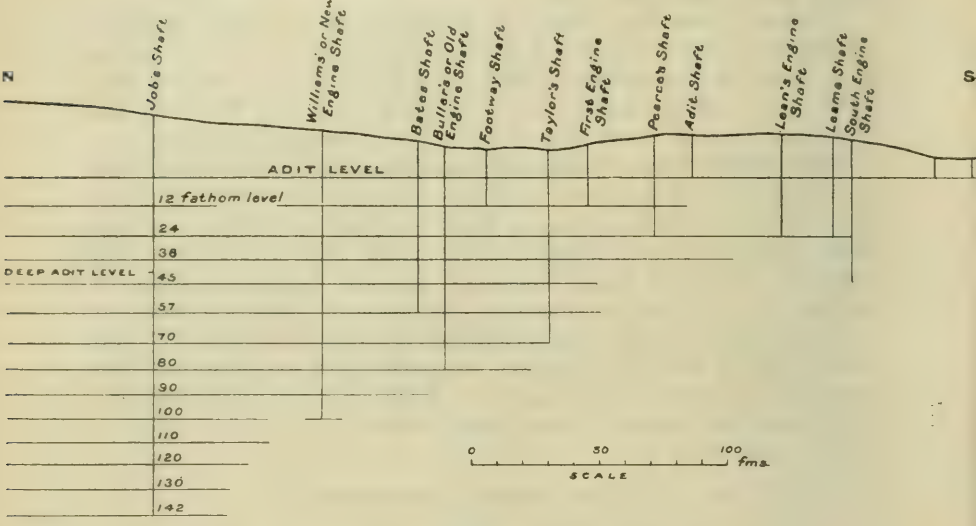

FIG. 6.—*Wheal Betsy. Section of Main Lode.*

13 levels at 10-fthm. intervals, besides the adit which lies at 70 fthms., the most extensive workings being those down to the 80-fthm. level. The new engine shaft was 100-fthms. and Job's Shaft 140 fthms. deep. The ore body is largely stoped away down to the 140-fthm. level.

The output between 1845 and 1848 and from 1868 to 1877 amounted to 1,080 tons of lead-ore which contained 540 tons of lead and 2,020 ozs. of silver. Prince Arthur had an output of 465 tons of lead-ore, 340 tons of lead, and 4,725 ozs. of silver; and North Wheal Friendship, 340 tons of lead-ore, 212 tons of lead, and 1,771 ozs. of silver between 1854 and 1860.

WHEAL BROTHERS (FORMERLY WHEAL DUCHY), CALSTOCK.

(*Idle.*)

The shafts are situated about half a mile west of Harrowbarrow, and 2½ miles by road from Callington.

Maps.—One-in. New Series Ordnance and Geological, 337; 6-in. Cornwall, 29 S.E.

Memoir.—" The Geology of Tavistock," pp. 92, 111, 113, 120.

The country-rock consists of Upper Devonian slate.

According to the above-mentioned memoir " a considerable amount of silver was obtained from a copper lode striking

[1] Henwood, W. J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. V, 1843, Table XCVIII.

E. 16° N. The ore contained ruby silver-ore, and the black oxide, as well as native silver." Collins states that "by 1816 the mine had yielded more than £5,000 worth of silver all from a leader from 1 to 4 ins. wide, in a lode varying from 6 to 12 ins. Some detached lumps which assayed 70 per cent. for silver were found in the 10-fthm. level, where also was a rich leader which extended for 3 fthms. in length. Silver was also found in the 20-fthm. level, and later in the 30-fthm. level. In 1833 the mine was re-opened as Wheal Brothers, when a considerable quantity of argentiferous gossan was found, which was sold at prices varying from £2 up to £500 per ton. At the 30-fthm. level one part of the lode was valued at £500 and even £600 per fathom. In three months . . . no less than £5,847 worth of silver ore was raised and sold . . . considerable quantities of silver were raised during the next four months and £9,000 was paid in dividends."[1]

Carne states that "in the adit, silver ore was found in detached lumps, with small bunches of native silver. In the 10-fthm. level, there was a regular course of silver ore, accompanied by native silver, for nearly 3 fthms. in length . . . this was the richest part of the mine."[2] Wheal Sisters[3] was worked in 1863 on an eastern part of the same lode.

Wheal Newton (or Wheal Fortune), Calstock.

(Idle.)

The old shafts are situated on both sides of the road through Harrowbarrow, a little over 2 miles east of Callington.

Maps.—One-in. New Series Ordnance and Geological, 337; 6-in. Cornwall, 29 S.E. H.O. Plan No. 2961, deposited at H.O. in 1893.

Memoir.—"The Geology of Tavistock," pp. 101, 102, 114, 121, 122.

The mine has been called the Queen and the South Harrowbarrow.

The country-rock consists of Upper Devonian shales.

The Harrowbarrow Lode (Fig. 7) and the Well Lode (Fig. 8)

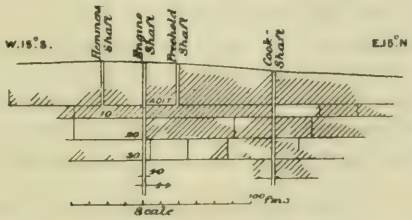

Fig. 7.—*Wheal Newton. Section of the Harrowbarrow Lode.*

[1] *Journ. Roy. Inst. Cornwall*, Vol. XVI, 1904, pp. 113, 114.
[2] *Trans. Roy. Geol. Soc. Cornwall*, Vol. I, 1818, pp. 122, 123.
[3] Henwood, W. J., *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 115.

FIG. 8.—*Wheal Newton. Cross sections of lodes.*

course nearly east and west and at about 50 fthms. apart. The Well Lode has been worked for silver-ore; it underlies south and ranges from 6 in. to 2 ft. in thickness. "It has been worked to a depth of 50 fathoms at Cooke's Shaft. The ores of silver comprise native silver, pyrargyrite, and argentite, which were mingled with chalybite in the form of a vein from 4 to 6 ins. wide in fluccan. The silver content ranged from 50 to 300 ounces to the ton. Stephanite has also been found. In sinking Cook's Shaft the Well Lode was found to meet the Harrowbarrow Lode at the 30-fathom level, but from the 30 to the 40 the lodes kept together until at the 40 the Harrowbarrow Lode was cut off."[1]

According to Collins nearly 242 tons of silver-ore were raised from 1877 to 1879, while in 1880, 1881, and 1882 $3\frac{3}{4}$ tons were sold.[2]

EAST CORNWALL ST. VINCENT MINE, CALSTOCK.

(*Idle.*)

The mine is situated about five-sixths of a mile west-south-west of Harrowbarrow.

Maps.—One-in. New Series Ordnance and Geological, 337; 6-in. Cornwall, 29 S.E. Wheal Langford, H.O. Plan No. 2379, deposited at H.O. in 1888.

Memoir.—"The Geology of Tavistock," pp. 94, 121.

The country-rock consists of Upper Devonian slate.

The main lode courses E. 10° N., and contains native silver, the chloride and the sulphide of silver.[3]

The mine was known until 1824 as Wheal St. Vincent. In that year it ceased work, but was re-opened in 1835 as the East Cornwall Mine. After working for two years it was again closed down, but in 1855 it was worked in conjunction with Wheal Langford and yielded much argentiferous galena and silver ore.[4] According to Henwood[5] the output of silver-lead-ore amounted

[1] "The Geology of Tavistock and Launceston" (*Mem. Geol. Surv.*), 1911, pp. 101, 102.

[2] *Journ. Roy. Inst. Cornwall*, Vol. XVI, 1904, p. 116.

[3] Hogg, T., "Manual of Mineralogy," 1825, p. 21.

[4] "The Geology of Tavistock and Launceston" (*Mem. Geol. Surv.*), 1911, p. 94.

[5] *Trans. Roy. Geol. Soc. Cornwall*, Vol. VIII, 1871, p. 115.

to about one ton and a half as a result of about two years' work. He also states that the same mine was re-opened in 1848, under the name of Wheal Langford, when it was found that silver-ore became less and lead-ore more abundant as the mine was deepened. For several years the ore afforded from 0·001224 to 0·060466 its weight of silver. In June 1855, $2\frac{1}{4}$ tons of ore were sold for nearly £1,200. In 1855, 1856, 1857, 1883, and 1890 the output of lead-ore from Wheal Langford amounted to 52 tons containing 23 tons of lead and 2,530 ozs. of silver.

Another small mine known as Wheal Mexico was apparently on the eastern part of the same lode. During 1847–8 "it was wrought to an inconsiderable depth . . . and afforded the chloride of silver largely mixed with slaty clay, granular quartz, and the carbonate of iron. Some portions of the ore contained 0·001224, others 0·026316, their weight of silver."[1]

Some minor quantities of lead-ore have been raised at several other mines, but these are less than 50 tons in all. At Kingston Consols 311 tons of lead-ore with 1,050 ozs. of silver and 1,102 tons of zinc-ore were raised between 1876 and 1879. At Wheal Crelake, between 1860 and 1866 the output was 1,300 tons of lead-ore and 13,145 ozs. of silver, while a mine called Whitleigh raised 62 tons of lead-ore containing 1,436 ozs. of silver in 1855 and 1856.

The Ivybridge Mine, Ivybridge.

(*Idle.*)

The plan (R 79) of this mine is preserved at the Home Office, but there is no indication of the site. It may be the same as the Fillham Silver-Lead Mine, and if so, it is situated on 6-in. Sheet, Devon, 125 N.E., near the border of an old alluvial flat, and at 9 furlongs south-east from Ivybridge Church,[2] and on 1-in. New Series Ordnance and Geological Map, Sheet 349.

The country-rock consists of "metalliferous slate, with calcareous veins alternating with hard-blue slate and resting on dark contorted shale."

The lode courses nearly east and west and the dip of the country-rock is south at 45°.

VI.—The Christow District.

The mines situated in the valley of the Teign, between Hennock and Christow, were worked under the names of Frankmills, Wheal Exmouth, Wheal Adams, Reed, Aller, South Exmouth, and Bennah.

The Main Lode courses nearly $2\frac{1}{2}$ miles in a general northward direction; is either vertical or highly inclined to the east, and

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[1] Henwood, *op. cit.*, p. 115.

[2] "Geology of Ivybridge and Modbury" (*Mem. Geol. Surv.*), 1912, p. 116.

from 2 to 4 ft. wide. The galena from these mines contained from 10 to 20 ozs. of silver per ton of ore.[1] There was a good gangue in which barytes formed a common constituent, and quartz with a stellate grouping is often intergrown with it. Brecciated barytes cemented together with brown hæmatite and large lumps of manganiferous hæmatite are common, but no fluorspar was observed.

A second lode coursing parallel with and to the east of the main lode was worked at South Exmouth and at Frankmills. Nearly on the line of strike, and about three-quarters of a mile north-east of Bridford, barytes is still worked in a quarry where the rocks are shattered in the neighbourhood of a vein. The barytes fills the vein and spreads out as a cement into the shattered rock. It has a botryoidal form and frequently is associated with galena. The ore was discovered during a search for silver-lead-ore. A shaft has been sunk to a depth of 70 fthms., where the lode was narrower and contained a whiter variety of barytes.

The lode courses northwards from South Exmouth Mine through Frankmills, and Exmouth and thence in a direction slightly west of north through Reed, Aller, and Bennah Mines to Christow. North of Christow it has a bearing of about N. 20° W., and has been largely worked in the Bridford and Birch Mines.[2]

Frankmills, Christow.

(Idle.)

The shafts are situated about three-quarters of a mile north-north-east of Hennock Church and one and a half miles by road from Ashton Station (L. & S.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 339; 6-in. Devon, 101 N.W. H.O. Plans Nos. R 220 and 1243, deposited at H.O. in 1881.

Memoir.—" The Geology of Newton Abbot," pp. 128, 129, 130, 131, 132, 133.

The country-rock consists of grey shales and radiolarian chert of Carboniferous age.

There are two principal lodes which course nearly north and south. They underlie east in the upper 90 fthms.; and below that either west or vertical. These lodes are described as the Western Lode and the Eastern Lode. In part of the workings a small lode known as the No. 1 Branch Lode, and the Barytes Lode (Fig. 9) has been worked at the 20-, 40-, 60- and 72-fthm. levels; it underlies east at 1 in 2.

On the Eastern Lode most stoping has been done between the 45- and the 72-fthm. levels, and some near the shaft on the 115- and 130-fthm., but not much south of the shaft. On the Western Lode (Figs. 10 and 11) there is a lot of stoped ground from the

[1] Collins, J. H. *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 689.

[2] " The Geology of Newton Abbot " (*Mem. Geol. Surv.*), 1913, p. 129.

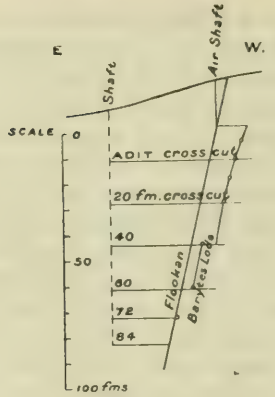

FIG. 9.—*Frankmills Mine.*

45- to the 72-fthm. and down to the 115-fthm. level near the Engine Shaft; also between the surface and the 45-fthm. level near the

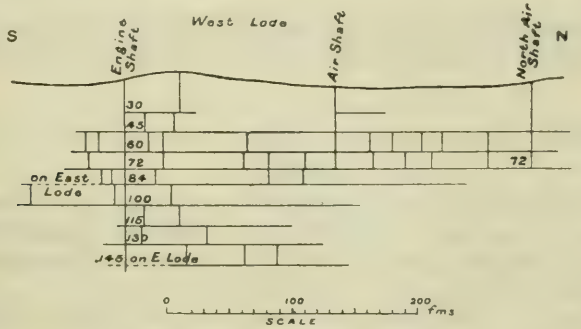

FIG. 10.—*Frankmills Mine.*

air shaft. Collins[1] states that the mine was worked below the 175-fthm. level.

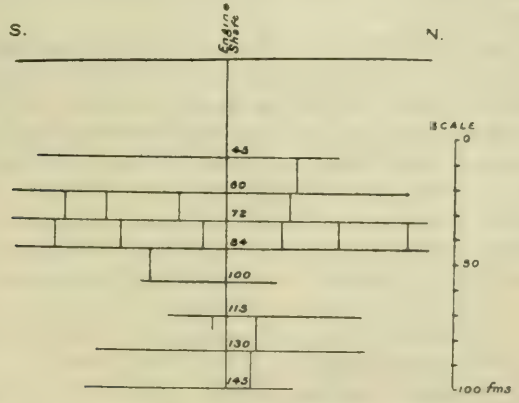

FIG. 11.—*Frankmills Mine.*

[1] "Notes on the Principal Lead-bearing Lodes of the West of England," *Trans. Roy. Geol. Soc. Cornwall*, Vol. XII, 1903, p. 689.

The Western Lode has been worked for a distance of nearly 400 fthms. from south to north. In all there are nine levels.

The lode ranged from 2 to 4 ft. in width. Its gangue consists in part of an intergrowth of barytes and quartz, but no fluorspar was observed on the waste heaps although the output of some is recorded.[1] Brecciated barytes cemented together with brown hæmatite and radiating quartz crystals is abundant, and large lumps of manganiferous hæmatite are common. Collins[2] notes the occurrence of "very beautiful crystals" of barytes "half an inch long or more," which he "obtained thirty years ago from some old levels, which had evidently been formed after those levels had been driven." He also remarks that the lode contained the usual fragmentary filling with occasional leaders of solid galena and veinlets of blende and pyrites, and carried argentiferous galena and cerussite.

The output of lead-ore between 1857 and 1880 amounted to 14,800 tons yielding 9,936 tons of metallic lead and 248,520 ozs. of silver.

The large dumps have been turned over for lead, but considerable quantities of barytes still remain. The mine is flooded.

Wheal Exmouth and Wheal Adams, Christow.

(*Idle.*)

The shafts are situated beside the road and the River Teign about one and a third miles from Ashton Station (L. and S.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 339; 6-in. Devon, 91 S.E. H.O. Plan No. R 220.

Memoir.—"The Geology of Newton Abbot," pp. 128, 129, 130, 131, 132, 133.

The country-rock consists of Carboniferous shales in part metamorphised by the Dartmoor granite. In the western part of the mine greenstone was encountered from the 84- to the 100-fthm. levels.

The Eastern Lode (Fig. 12) courses nearly due north and has an underlie to the west from the surface down to the 84-fthm. level, but below that level it is nearly vertical. The Western Lode is also nearly vertical down to the 100-fthm. where it joins the No. 1 branch which has an underlie west; the united lodes underlie east between the 100-fthm. and the 145-fthm. levels. It was worked on down to the 125-fthm. level by levels at 15-fthm. intervals, but principally at the 45-, 60-, and 84-fthm. levels.

It is stated that fluorspar was produced, but none of it could be found on the waste heaps although barytes is of common occurrence. At South Exmouth this lode, and another lying to the east of it, were worked to the 90-fthm. level.

The total output between 1851 and 1874 amounted to 10,500 tons of lead-ore, with 6,880 tons of lead and 118,000 ozs.

[1] "The Geology of Newton Abbot," (*Mem. Geol. Surv.*), 1913, p. 132.
[2] *Op. cit.*, p. 689.

of silver. There was also an output of 1,561 tons of zinc-ore between 1859 and 1874.

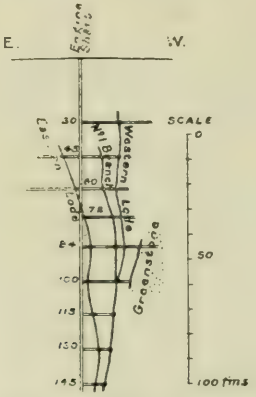

FIG. 12.—*Wheal Exmouth.*

Wheal Adams produced 1,220 tons of lead-ore, 670 tons of lead from 1845 to 1852, and 680 ozs. of silver in 1852.

SOUTH EXMOUTH MINE, HENNOCK.

(Idle.)

The mine adjoins and lies immediately to the south of Frankmills Mine, and is situated about one and a half miles by road from Ashton Station (L. & S.W.R.).

Maps.—One-in. New Series Ordnance and Geological, 339; 6-in. Devon, 101 N.W. H.O. Plan No. R 220.

Memoir.—"The Geology of Newton Abbot," pp. 129, 130, 132, 133.

The country-rock consists of grey shales and radiolarian chert of Carboniferous age.

The lodes course a little west of south and are called the East Lode and the West Lode. The former underlies west and the West Lode, east. The West Lode (Fig. 13) has been worked on at the 30-, 45-, 60-, 75-, and 90-fthm. levels; and the East Lode at the 30- and 45-fthm. levels. There are three shafts: Wescombe's Engine, James, and the Air Shaft.

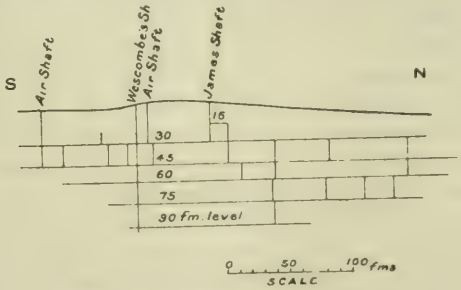

FIG. 13.—*South Exmouth Mine.*

The output of lead-ore between 1862 and 1867 amounted to 760 tons; it contained 530 tons of lead with 1,150 ozs. of silver.

VII.—North Devon District.

The Combe Martin Mines, Combe Martin.

(Idle.)

There are two disused mines situated to the east of the village street; the old mine is near Watery and Corner Lanes, and the new mine is on Knap Down nearly three quarters of a mile east of the old mine and on top of the steep hill above the village.

Maps.—One-in. New Series Ordnance, 277; Old Series Geological, 27; 6-in. Devon, 5 N.E. H.O. Plans Nos. R 155 and 1222, deposited at H.O. in 1881.

The country-rock consists of dark grey slate belonging to the Ilfracombe Beds of the Middle Devonian. The rock is riddled with quartz-veins and disseminated throughout the mass are crystals of extremely fine-grained silver-lead-ore and some chalcopyrite. There is also a pegmatitic growth of brown chalybite and quartz, with some veinlets of blende. The gangue consists principally of white quartz. The rare mineral millerite has been found on the dumps and specimens are preserved in the Barnstaple Athenæum. Antimonite was found rarely, in fibrous masses and acicular crystals. Fahlerz, or grey copper-ore, occurred as well as chessylite and malachite in the gossan. Native silver in small filaments was noted in the galena. The lead contained as much as 168 ozs. of silver per ton.

In the reign of Edward I. (1293), William de Wymundham accounted at the Treasury for 270 lbs. of Combe Martin silver. In the following year the produce amounted to £521 10*s.*, and in 1295 it was worth £704. During the next year Edward I. sent from Derbyshire 337 men to deepen the mine. Again in 1297, 260 miners were imported from the Peak and also from Wales. Grants to the miners made by Edmund, Earl of Kent, half-brother of Edward I., were confirmed by a charter in 1305. This deed also separated the Stannaries of Devon and Cornwall. A large part of the war expenses of Edward III. and of Henry V. were paid by the sale of Combe Martin silver. In 1364 an order was issued forbidding the exportation of precious metals from Barnstaple and Ilfracombe. A new silver mine was discovered in the reign of Elizabeth by Adrian Gilbert, who was assisted by John Poppler, a lapidary. He was brother of Sir Humphry Gilbert, and half-brother of Sir Walter Raleigh. The mine was worked for four years, and each of the two partners received £10,000. Queen Elizabeth imported miners from the Hartz Mountains to help work the mine. This "Faye's Mine" was soon sunk to a depth of 32 fthms., and an ore-shoot was worked which yielded profits up to £20,000 a year. A Mr. Bulmer bargained with Gilbert and Poppler for one half of the mine.

He visited Combe Martin and there "found great store of ewer." Mr. Bulmer presented to the Corporation of the City of London a cup made from the last cake of silver smelted from the ore. On it were inscribed a verse and the portrait of the donor.[1] In 1659 it was strongly recommended to the Long Parliament that the mines should be re-opened, but it was not until the close of the 17th century that they were re-worked and then without success. There is in existence a letter in the hand-writing of Charles I. which refers to these mines and states that "we have had a sight of the Oare, which we conceive lyes there in vast proportions according to the Testimony of Ancient Record in that behalfe."[2]

The silver mines were re-opened in 1813 and worked for three years, 208 tons of ore being then shipped to Bristol. In 1835 a new lode was discovered, but it was displaced by a cross-course and in 1848 the mines again ceased work. The quantity of silver metal to the ton of ore varied from 20 to 168 ozs., and it is said that the silver-lead realised a higher price than any other in the kingdom.[3]

In 1875 the mines were again opened up, but without success. There are two mines whose shafts are respectively 40 fthms. and 112 fthms. deep, but elsewhere in the district there are many old levels.

According to Kingdon[4] the ore is generally massive and free from waste. The old Combmartin lode and two others to the north of it, were the first to be worked. In 1835 all the ore down to a depth of 20 fthms. had been removed. Afterwards the ore at Knap Down mine was explored to a depth of 118 fthms. from the surface. It lay between two dislocations which converged, the greatest distance between them being 40 fthms. Ore to the value of £60,000 was recovered.[5]

In the north and south parallel there are four or five other ore-producing lodes, the most southerly of which is the one probably associated with Adrian Gilbert's working.

Kingdon continues that "intermediate between this and the old Combmartin lode proper is a lode sunk through in the engine shaft 50 fthms. deep. It lies deep under the centre of the valley. North of the Combmartin lode is a lode at the 27-fthm. cross-cut where it produced several tons of fine-grained ore. Still further north are sites of extensive ancient works, as well as new lodes. At the deepest point attained, ore was as strong, thick, and, if anything, richer for silver than in the levels. At the deepest part of the mine the Great South lode converges towards the Old Combmartin lode."

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[1] Hunt, R., "British Mining," 1884, pp. 129–130.
[2] Toms, K. M., "Notes on Combe Martin," Barnstaple, 1902.
[3] Toms, *op. cit.*
[4] "The Silver Mines at Combmartin," *Trans. Devonshire Assoc.*, Vol. II, 1867–8, pp. 190–199.
[5] Kingdon, *op. cit.*

According to the plans preserved at the Home Office the mine situated near Watery Lane was worked to a depth of 40 fthms. There are six lodes underlying south at 40° from the vertical and coursing east and west. Harris's Lode and the North Lode were the principal ones worked. There were three levels at 15, 28, and 40 fthms. respectively below grass. Most ore was got near the shaft between the surface and the 28-fthm. level, and on both sides of a winze east of the shaft between the 15- and the 28-fthm. levels.

For the following remarks we are indebted to Mr. Franklin White, M.I.M.M., who kindly placed his report on the Combe Martin Mines at the disposal of the Survey.

He states that there are three main groups of veins coursing nearly east and west. The northernmost, or the West Challacombe group; the central, Knap Down or Harris group; and the south-eastern group. He is of opinion that the West Challacombe Mine is the earliest one worked. Two adits were driven eastward from the beach. The mine on Knap Down, he says, is 60 fthms. deep. A tunnel was driven north from a point a little east of Buzzacott House for a distance of about 960 feet to cut the Knap Down Lode, but it was left unfinished. It would probably have reached the lode some 275 feet below the top and 1,200 feet east of the shaft had it been continued for another 250 feet.

On the Harris Lode a shaft near the Old Manor stables is said to have been sunk to a depth of 618 feet, the top being about 100 feet above sea-level. It is estimated that the shaft would have to be sunk to 1,200 feet to meet the lode. An adit below Bowhay Lane was commenced with the intention of unwatering the mine but was left unfinished. Mr. White concludes that, although the existence of wide and extensive ore-bodies in the Combe Martin District is improbable, there is reason to expect some shoots of ore of good value.

Pickards Down Lead Mine, Barnstaple.

(*Idle.*)

The shaft is situated on Pickards Down, about 1 mile east of Barnstaple Parish Church.

Maps.—One-in. New Series Ordnance, 293; Old Series Geological, 27; 6-in. Devon, 13 N.E.

The country-rock consists of Upper Devonian slates.

The veinstone contains barytes and calcite and the galena is argentiferous. All that remains of the mine are some open-cast workings and refuse heaps.

Upcott Mine, North Molton.

(*Standing.*)

Shafts situated about 4 miles north of South Molton Station (G.W.R.), and 1¼ miles E.S.E. of North Molton Church.

Maps.—One-in. New Series Ordnance, 293; Old Series Geological, 27; 6-in. Devon, 15 S.E.

The country-rock consists of Upper Devonian slate.

The lode courses east and west and underlies south. It measures from 18 to 20 ins. in thickness and contains, in addition to galena, some copper pyrites. The galena contains silver. In the upper part of the lode there is much iron-pyrites. The gangue consists principally of sandstone fragments cemented together with quartz.

The lode is said to have been a good deal worked in the past.

The shaft has been sunk to a depth of 27 fthms. and there is a winze another 10 fthms. deep below this level. The mine is flooded.

Output : 25 tons of lead-ore yielding 9 tons of lead.

CHAPTER IV.

SOMERSET.

The Mendip Mineries.

History.—Lead-ores have been mined on the Mendip Hills intermittently for a period of nearly two thousand years, for it is probable that they were worked by the British inhabitants before the Roman occupation. The Romans mined the ore and cast the metal into pigs on an extensive scale. Many of the pigs which have been found along the course of the Roman road that traverses the Mendips from east to west bear the imperial stamp, and from these it is known that the work continued from the time of Claudius to that of the Antonines. Some of them, neatly cast, bear the letters *ex arg.*, which Dr. Percy considered "clearly mean *ex argento*, free of silver or desilverised."[1] The Roman miners left enormous accumulations of slag and slimes, but it is probable that they obtained the ore from shallow workings, as no ancient adits, headings, or sinkings[2] have been discovered in the Mendips; and Pliny[3] especially remarks upon the abunddance of lead-ores in the upper crust of the earth in Britain, and on a law that was made which forbade the manufacture of more than a stipulated quantity of lead from those ores. What appears to be the next record is an ancient charter and pictorial plan of the time of Edward IV., of which a facsimile is published in Hunt's "British Mining," and a slightly different version by McMurtrie.[4] On this plan are shown the roads and parishes and the four mining divisions or "mineries," of Priddy, Chewton, West and Harptry; while sketches of mining tools and the methods of mining by fire and drill are depicted on the margins. McMurtrie also reproduces the orders and ancient customs of the mineries from the reign of Edward IV. to the end of the 18th century. The method of discovering the ores in the 17th century is described by Giles Pooley,[5] while W. G. Maton[6] gives an account of the mines in 1797.

The mining and smelting operations as carried on in the 17th century have been described by Mr. Joseph Glanvil,[7] who says that "they beat the Ore with an Iron flat piece; cleanse it in water from the dirt; sift it through a Wire-sive. The Ore tends to the bottom, and the Refuse lies at the top." He then describes

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[1] "The Metallurgy of Lead," 1870, p. 214.

[2] Morgans, *Trans. Inst. Mining Engineers*, Vol. XX, p. 487.

[3] "Naturalis Historia," book XXXIV, chapter 17, section 49.

[4] *Trans. Inst. Mining Engineers*, Vol. XX, pp. 528–82.

[5] *Phil. Trans., Roy. Soc.*, 1693, Vol. XVII, p. 672.

[6] "Observations on the Western Counties of England," 1797, Vol. II, p. 131.

[7] *Phil. Trans. Roy. Soc.*, 1668, Vol. III, No. 39, p. 770; reprinted in "*The Metallurgy of Lead*," John Percy, 1870, p. 537.

the hearths and methods of smelting the ore, and remarks that the lead is "cast into Sand, and runs into those Sowes (as they call them) which they sell," and also states that "there is much difference in the goodness of the Ore. The Cleerest and heaviest best. 36 hundred of ore may yield a tun of lead," and further that "the fumes poison the cattle." It is still asserted locally that sheep and horses suffer from eating grass that grows on the slimes or on ground where the ore occurs.

Mr. Morgans states that "from the beginning of the seventeenth century up to about 1870, operations in mining on a more or less extensive scale were conducted on the Mendips. Part of this mining was for lead and part for zinc-ores. The treatment of the Roman slags for recovery of lead was begun in the thirties or forties of the present century, and later a beneficiation of the Roman tailings and slimes was attempted and carried on with some success while lead stood at a good price. Three or four separate firms erected dressing and smelting plants and at Charterhouse lead works a small Pattinson plant for desilverising was erected."[1] Smelting operations were conducted 50 or 60 years ago at St. Cuthbert's, the material being the black slag left from previous treatment of the Roman grey slag, which contained about 5 per cent. of lead. Subsequently to 1850, the material smelted consisted of a mixture of *débris* and slime-concentrates, lead-fume or flue-dust, such grey slags as were left by earlier workers and some black slag. The concentrates were prepared by means of buddles of rather small diameter of bed. The *débris* and slimes were dressed up to a lead content of 40 to 45 per cent., equivalent to between 51½ and 58 per cent. of lead carbonate, in which form the lead was said chiefly to exist. The balance of 40 per cent. and more is supposed to have consisted mainly of sand.

The lead-fume from the furnace was condensed and precipitated, and the ore and fuel-dust, mechanically carried with the furnace gases, were collected in flues, of which there was a length of 2,400 ft. The flue-soot contained from 50 to 60 per cent. of metallic lead.

In after years the crude *débris* was smelted without previous concentration, and the final yield of pig-lead was estimated to be about 6½ per cent. of the weight of the *débris* treated. The lead contained 3 ozs. of silver to the ton. The slags were claimed not to contain more than 1 per cent. of lead. Inclusive of the flux, the mean lead content of the charge was, doubtless, not below 8 or 9 per cent. About 1900 a concentrating and smelting plant of modern description was erected at St. Cuthbert's lead works. The plant consisted of revolving barrels for disintegrating, a picking belt, classifiers, jigs, Wilfley tables, and a Frue vanner. In 1900 these were the only lead-works on the Mendips. In 1919 all the works were idle.

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[1] *Trans. Inst. Mining Engineers*, Vol. XX, 1902, pp. 478–94.

Morgans states that " besides the very extensive deposits of lead-*débris* and tailings existing in the neighbourhood of St. Cuthbert's lead works, there are other considerable deposits occupying more than 1 mile of the length of the valley extending south-westward from Charterhouse lead works. From numerous tests that have been made it is estimated that the deposits in general contain from 8 to 10 per cent. of metallic lead in the forms of ore and slag."[1]

Nearly the whole surface of the Mendip Hills has been prospected for ores and there remain numerous shallow trenches or " grooves," as they are locally termed, where trials have been made, the majority being small and only partially successful. The more important workings, which have been productive of larger outputs, are situated at the following localities :—

Locality.	One-inch New Series Ordnance Map.	Old Series Geological Map.	Six-inch Map Somerset.
Tar Valley	280	19	28 N.W.
Priddy	280	19	27 N.E.
Charterhouse	280	19	18 S.E.
Shipham	280	19	17 N.E. and 18 S.W.
Rowborough	280	19	18 N.W.; S.W.
Winscombe	280	19	17 S.E.
Worle Hill	263 and 279	20	9 S.E.
Brean Down	279	20	16 S.W.
Broadfield Down, especially near Wrington	280 and 264	19	11 S.W.
Near East Harptree	280	19	19 S.W. and 28 N.W.

Most of the larger workings are not deeper than 12 fthms. and few exceed 20 fthms. Two are mentioned, however, which attain depths of 270 ft. and 480 ft. The first is a shaft at Charterhouse,[2] and the other, one north-west of Shipham, where the waters gained so fast on the miners, that" for want of engines they can never work deeper."[3]

Geology.—The ores of lead and zinc occur in both the Carboniferous Limestone and the Dolomitic Conglomerate, galena being more abundant in the limestone, and calamine in the conglomerate. The ores have also been found in deposits assigned to the Rhaetic and to the Lias.

In the Carboniferous Limestone the ore is found in veins and lodes coursing nearly east and west, and in others at right angles

[1] *Op. cit.*, pp. 491, 492.

[2] Moore, C., *Quart. Journ. Geol. Soc.*, Vol. XXIII, 1867, p. 492.

[3] Maton, W. G., " Observations on the Western Counties of England," 1797, Vol II, p. 131.

to that direction. Calcite, barytes, quartz, and iron-ores accompany the galena and near the surface some cerussite occurs. Weaver was an eye-witness of the mining operations when they were in great activity, and in his description the veins are said to be "characterised by walls of white granularly foliated limestone, from which proceed on either side columnar concretions of calcareous spar, meeting in the middle . . . and sometimes . . . of a beautiful congeries of balls, composed of columnar concretions radiating from a common centre."[1] Maton says that "the most productive lodes are enclosed between very hard rocks of limestone that exhibit a greyish fracture, but have a deep red surface, occasioned by the oxyde of iron. . . . The lodes were from $\frac{1}{2}$ in. to 2 ins. in thickness."[2] He emphasises their discontinuity and replacement by "loose ochry substance and sometimes clay," and states that the galena is more refractory than that of Derbyshire. In his time there were no adits and "the miners worked up to their chins in water." There appears to have been considerable doubt about the depth to which the lodes extended for whereas Moore[3] states that the mineral veins appear to pass downwards through the whole thickness of the Carboniferous Limestone, Morgans[4] says: "beds of lead-ore in, and conformable with the bedding of, the Carboniferous Limestone, with such ore-beds at different horizons in the bedding and, perhaps, connected by leaders traversing joints in the limestone perpendicular to the bedding-planes, are not known in the Mendips, but sporadic strings and small nests of galena occasionally occur."

Calamine, or the carbonate of zinc, has been mined principally in the Dolomitic Conglomerate, especially in the parishes of Shipham and Rowborough, and also near Rickford and on Broadfield Down.

The conglomerate is traversed by veins, "sometimes in such numbers as to constitute a kind of net-work on a large scale; the veins observing no regular order in the dip, but being sometimes vertical, and often inclined one way or the other indifferently. They vary in width from one to six ins., but are sometimes enlarged to the breadth of one, two, and three ft., particularly at the point of intersection."[5] Buckland and Conybeare examined the workings when they were well exposed, and describe the mode of occurrence of the ores in the conglomerate in the following words:—

"The conglomerate is often metalliferous, yielding occasionally some galena, and more frequently calamine, in some abundance. These ores occur sometimes in small veins, but are usually disseminated through the rock, particularly when it is charged

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[1] "Geological Observations on Part of Gloucestershire and Somersetshire," *Trans. Geol. Soc.*, Ser. 2, Vol. I, 1824, p. 367.

[2] *Op. cit.*, pp. 131, 132.

[3] *Quart. Journ. Geol. Soc.*, Vol. XXIII, 1867, p. 455

[4] *Trans. Inst. Mining Engineers*, Vol. XX, 1902, pp. 487–8.

[5] Weaver, *Trans. Geol. Soc.*, Ser. 2, Vol. I, 1824, p. 367.

with calcareous spar. The galena, when thus disseminated, occurs in angular fragments; it appears pretty extensively in this form in the compact, yellow dolomite of Old Clevedon and Portishead. Much of the calamine has been formed stalactitically around dog-tooth spar, and is now found in the shape of hollow casts and pseudomorphic crystals, in consequence of the calcareous matter having perished. These ores are probably of simultaneous origin with the conglomerate itself, having been derived mechanically from the *débris* of metalliferous veins which traversed the mountain limestone."[1]

In 1839, De la Beche stated that one or two calamine works were being operated; the ore then contained 64·8 per cent. of zinc.[2]

The Rhaetic and Liassic ores have been described by several writers. In 1867 Mr. Charles Moore[3] described some veins in the Carboniferous Limestone, which contained metalliferous deposits of Liassic age. He remarks that these veins "appear to pass downwards through the whole thickness of the Carboniferous Limestone, and have been proved at Charter House to a depth of 260 feet. In general, they are of Liassic Age. . . . As we are able to arrive at the age of horizontal strata by the fauna they enclose, so we are able to indicate in many cases the probable relative age of mineral and other veins by the same palaeontological law." At the bottom of the Charterhouse shaft there was a deposit 12 ft. thick, of deep-blue or greenish clay, in places conglomeratic, which contained 7 per cent. of galena. It was rich in fossil shells, at least 115 species having been discovered. Moore remarks that "the mineral veins of the district show most conclusively that the Carboniferous Limestone must for a very long-extended period have been within the influence of the Liassic seas, and from the latter must have derived most, if not all, of their mineral treasures, whether iron, or lead, or calamine."[4] H. B. Woodward, however, differed from this conclusion. He says "The presence of fossil remains in these veins merely shows that there was an infilling during or after the Penarth period. The physical evidence seems to me to point to the second of these conclusions, and I incline to refer the introduction of these Penarth organic remains into the Mendip veins to a period not earlier than Tertiary and possibly to Glacial times. The formation of the veins themselves may have been going on ever since the consolidation of the rocks which they traverse. . . . They may, therefore, be of all ages subsequent to the Carboniferous period, and we can thus understand the occurrence of the ores disseminated in the strata,

[1] *Trans. Geol. Soc.*, ser. 2, Vol. I, 1824, p. 293.

[2] "Rept. Geology of Cornwall, Devon and West Somerset," 1839, p. 616.

[3] "On Abnormal Conditions of Secondary Deposits," *Quart. Journ. Geol. Soc.*, Vol. XXIII, 1867, pp. 449–568

[4] *Op. cit.*, p. 537.

as well as in veins; the former being due to the destruction of the latter."[1]

Deposits of much the same age have been found along the sides of the Carboniferous Limestone ridge that extends into South Wales. They were claimed by E. B. Tawney[2] as of Rhaetic age. In particular he describes the Sutton Stone, a soft conglomeratic freestone in part, which contains much disseminated galena but not in workable veins. It is in this form scattered plentifully along the coast and at Candleston, where an attempt was made to work it. A more recent failure is that of Llangan where a shaft was sunk and buildings half erected before the attempt was abandoned. Cubic crystals of galena were also found elsewhere in the shales. A variety of the conglomerate at Candleston is described by De la Beche as a rock containing "small cavities, often the casts of shells, which is very plumbiferous, galena being distributed through it and even filling up the cavities left by the disappearance of the shells."[3] Near Dunraven in South Wales he found galena entering into the joints of fossil plants. "The plumbiferous character of the rocks in this locality is interesting. Strings of galena are observed in the carboniferous limestone occasionally; indeed, a lead lode which has been worked at Gelli arail on the E.N.E. is prolonged to St. Bride's Down. Sprigs of the same ore are distributed here and there in the dolomitic conglomerate . . . Galena is found . . . in the Sutton Stone of Candleston . . . enters into the joints formed in the jet-like plants contained in the beds of grey Lias limestones."[4]

Origin of the Ores.—From the foregoing descriptions it appears that ores of lead and zinc occur in the Carboniferous Limestone, the Dolomitic Conglomerate, the Rhaetic, and the Lias.

There are, therefore, several periods of mineralization, but from their mode of occurrence and character it is probable that all the ores in rocks of later age than the Carboniferous Limestone have been derived from the veins in that formation. From what is known of the origin of the tin- and the copper-lodes of the West of England it appears highly probable that the veins in the Carboniferous Limestone arose from emanations given off from an igneous mass. The later deposits seem to have been derived from these veins, but the precise mode of their formation is uncertain. Buckland, Conybeare,[5] and H. B. Woodward[6] were of opinion that the ores were deposited as

[1] "Geology of East Somerset and the Bristol Coal-Fields" (*Mem. Geol. Surv.*), 1876, pp. 173–5.

[2] "On the Western Limit of the Rhaetic Beds of South Wales," *Quart. Journ. Geol. Soc.*, Vol. XXII, 1866, pp. 72–4.

[3] *Mem. Geol. Surv.*, Vol. I, 1846, p. 272. See also 'The Country around Bridgend' (*Mem. Geol. Surv.*), 1904, pp. 106–7.

[4] *Op. cit.*, p. 273.

[5] *Op. cit.*, p. 291.

[6] "Geology of East Somerset and the Bristol Coal-Fields" (*Mem. Geol. Surv.*), 1876, pp. 173–5.

detritus among the sediments and were changed subsequently by chemical action. An alternative explanation would ascribe their origin to solutions derived from the lodes in the Carboniferous Limestone, and in favour of this hypothesis may be quoted two instances described by De la Beche[1] where casts of fossil shells were filled up with galena, and another where crystals of galena were found in the joints of fossil plants.

The accompanying figure (Fig. 14) shows the annual output

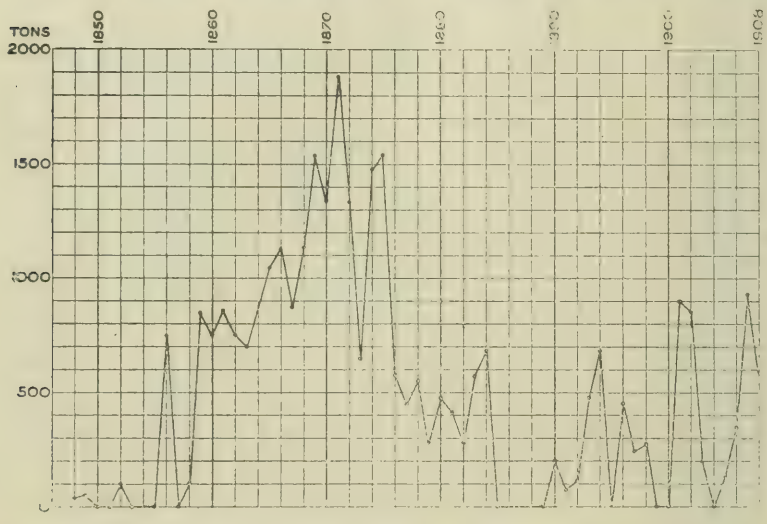

FIG. 14.—*Graph showing output of lead-ores, &c., from the Mendip Mines.*

in tons of lead-ore, slimes and slags from the Mendip Mines during the period 1848–1908. The total amount is upwards of 32,000 tons, with a yield of nearly 12,000 tons of metallic lead. The silver averaged $3\frac{1}{2}$ ozs. per ton of lead. Some picked samples assayed 10 per cent. of silver.

[1] *Mem. Geol. Surv.*, Vol. I, 1846, p. 272.

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